3rd Annual Disruptive Technology Conference

"Seeking the Capability Befor the Capability is the Surprise"

6-7 September 2006

Washington, DC

Onsite Conference Brochure

Keynote Address -- Technology Surprise—Why should we worry?
Dr. Ruth David, Chair, Committee on Defense Iintelligence Agency
Technology Forecasts and Reviews, President and CEO, ANSER, Inc.

Panel -- The Warfighter's Perspective
The Impact of Disruptive Technologies on Joint Warfighting
MG Michael Vane, USA, Vice Director for Force Structure, Resources & Assessment, Joint Staff, J-8

Panel -- Perspectives of Change: Identifying the Emerging Commercial Disruptive Technologies
Decision & Analysis as a Disruptive Technology
Dr. Desmond Saunders-Newton, BAE Systems, AlphaTech Division

Open Source GeoSpatial Tools and their Future Impact
Mr. Mark Lucas, Board Member OSGeo, RadiantBlue Technologies

Panel -- The Search for Disruptive Technologies - a "Blue Force" Multiplier
Advanced Capability Electric Systems
Mr. Scott Littlefield, PEO Ships Science & Technology Director, Office of Naval Research

Panel -- Disruptive Technology Policy and Focus
The Military Options to the Use of Commercially Available Disruptive Technology
Mr. Mark Johnson, Co-Founder and President, Innosight, LLC

Panel -- Ubiquitous Platform to PlayStation Disruptive Technologies
A Concept of Operations for Armed Autonomous System
Mr. John Canning, Chief Engineer, Advanced Engagement & Autonomous Warfare Systems, Naval Surface Warfare Center, Dahlgren Division

Real-Time Spectrum Management for Wireless Networks
Mr. Daniel Stevenson and Dr. Arnold Bragg, RTI International

3rd Annual Disruptive Technology Conference

"Seeking the Capability Before the Capability is the Surprise"

Onsite Conference Brochure

September 6-7, 2006
Hyatt Regency Washington on Capitol Hill
Washington, DC
Event #6920

THIS CONFERENCE IS OPEN TO U.S. CITIZENS ONLY

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

in coordination with the ODDR&E

Conference Agenda

Wednesday, September 6, 2006

7:00am - 5:00pm — **Registration**

7:00am - **Continental Breakfast**

8:00am — **Welcome Remarks**
Mr. Sam Campagna, Director, Operations, NDIA
Dr. Steven Kimmel, Chair, NDIA C4ISR Division, Senior Group Vice President, Alion Science & Technology Corporation

8:30am — **Plenary Session**

Keynote Speaker: *Dr. Ruth David*, Chair, Committee on Defense Intelligence Agency Technology Forecasts and Reviews, President and CEO, ANSER, Inc.

9:15am — Invited Speaker: *Dr. George Atkinson,* Science & Technology Adviser to the Secretary of State

10:00am — **Break**

10:30am — **The Warfighters' Perspective**
Technological breakthroughs in other countries could ultimately change the nature of military operations, alter the concepts of warfare, and help identify technologies the U.S. needs to develop. Strategically, we must be attentive to the consequences and opportunities offered by technological breakthroughs and plan accordingly. Not only must we be aware of the technology breakthroughs of a potential adversary, but we must also invest in those technologies that will provide a hedge against future uncertain threats. Speakers will discuss the effect of an adversary's technology surprises upon the Combatant Commander's ability to execute the assigned military mission and on the identification of those technologies that may provide a hedge against such surprises.

Moderator: *Mr. Wayne Snodgrass,* Consultant

Conference Agenda

The Warfighters' Perspective Panel Continued:

Speakers:

The Impact of Disruptive Technologies on Joint Warfighting
MG Michael Vane, USA, Vice Director for Force Structure, Resources & Assessment, Joint Staff, J-8

Joint Warfighting and Disruptive Technologies
Mr. George Bowers, Deputy Director, Joint Prototype Pathway, Joint Experimentation, U.S. Joint Forces Command

Disruptive Technologies for Special Operations Forces
Mr. Steven Kundrat

12:00pm **Lunch**

1:00pm **Perspectives of Change: Identifying the Emerging Commercial Disruptive Technologies**
A successful science and technology program will work to hedge against the uncertainty brought about by disruptive technologies and partner with industry in an attempt to identify them early. This session will provide an industry perspective on what the emerging commercial disruptive technologies are that could provide a significant increase in U.S. warfighting capability and what steps the DoD should take to achieve an effective partnership that will rapidly provide that capability.

Moderator: *Mr. Fred Lash,* Vice President, VSE Corp.

Speakers:

Decision & Analysis as a Disruptive Technology
Dr. Desmond Saunders-Neuman, BAE Systems, AlphaTech Division

Open Source GeoSpatial Tools and their Future Impact
Mr. Mark Lucas, Board Member OSGeo, RadiantBlue Technologies

Identifying Potential Implications of Technologies on Military and Security Operations
Mr. Robert Webb, Defence R&D Canada

2:30pm **Break**

Conference Agenda

3:00pm **The Search for Disruptive Technologies - a "Blue Force" Multiplier**

This session will explore ongoing U.S. Government funded RDT&E initiatives whose potential will provide significant benefits to the U.S. military's ability to accomplish the National Military Strategy.

Moderator: *Mr. Mike Devine,* Vice President, Alion Science and Technology

Speakers:

Disruptive Technologies: Understanding the Future
Dr. Michael Macedonia, Director, Disruptive Technology Office National Security Agency

Networking the Soldier and Immersive Training
Mr. Dennis Schmidt, Director Science & Technology Integration, Office of the Assistant Secretary of the Army for Research & Technology

Advanced Capability Electric Systems
Mr. Scott Littlefield, PEO Ships Science & Technology Director, Office of Naval Research

Air Force Science & Technology Challenges for Directed Energy
Dr. Bruce Simpson, Director Air Force Research Laboratory Directed Energy Directorate

5:15pm - 6:15pm **Reception**

Conference Agenda

Thursday, September 7, 2006

7:00am - 12:30pm **Registration**

7:00am **Continental Breakfast**

8:00am **Disruptive Technology Policy and Focus**

In this session representatives from the policy, industry, and scientific & engineering communities will provide their perspective on strategic challenges and identify which technologies possess the greatest potential to produce increases in military capability. Rapidly transitioning these technologies into advanced warfighting capabilities continues to be a challenge and has long been a concern of both DoD and industry. The pressure to rapidly transition the latest technology into military apability has become more intense because of the rapid growth and globalization of technology development. Potential adversaries may have access to these technologies and achieve their own disruptive capabilities. This session will examine how the Department and industry can work together to identify disruptive technologies and their likely military payoff.

Moderator: Mr. Alan Shaffer, Director, Plans & Programs, ODDR&E

Speakers: **Integrated Perspectives on Technology Development for National Security**
Dr. Kevin Geiss

Challenges and Impact of Disruptive Technologies
Honorable Ryan Henry, Principal Deputy Under Secretary of Defense for Policy

The Military Options to the Use of Commercially Available Disruptive Technology
Mr. Mark Johnson, Co-Founder and President Innosight, LLC

9:45am **Break**

10:00am **Ubiquitous Platform to PlayStation Disruptive Technologies**

Moderator: *Mr. John Scott*, Director Open Integration, RadiantBlue Technologies

Conference Agenda

Ubiquitous Platform Panel Continued:

Speakers:

A Concept of Operations for Armed Autonomous System
Mr. John Canning, Chief Engineer, Advanced Engagement & Autonomous Warfare Systems, Naval Surface Warfare Center, Dahlgren Division

X-Ray Backscatter Imaging as a Tool for Persistent Surveillance
Mr. William Baukus, Director, Technology Development, American Science and Engineering, Inc.

Real-Time Spectrum Management for Wireless Networks
Mr. Daniel Stevenson and Dr. Arnold Bragg, RTI International

Anti-Tamper and Disruptive Technologies
Mr. Gordon Boezer, Research Staff Member, Institute for Defense Analysis

Open Technology Development Concept
COL Terry Mitchell, USA (Ret), Advanced Systems and Concepts Office, Under Secretary of Defense (AT&L)

12:30pm **Conference Adjourns**

Displayers:

Defense Technical Infomation Center

Germane Systems, LC

Optimer Photonics, Inc.

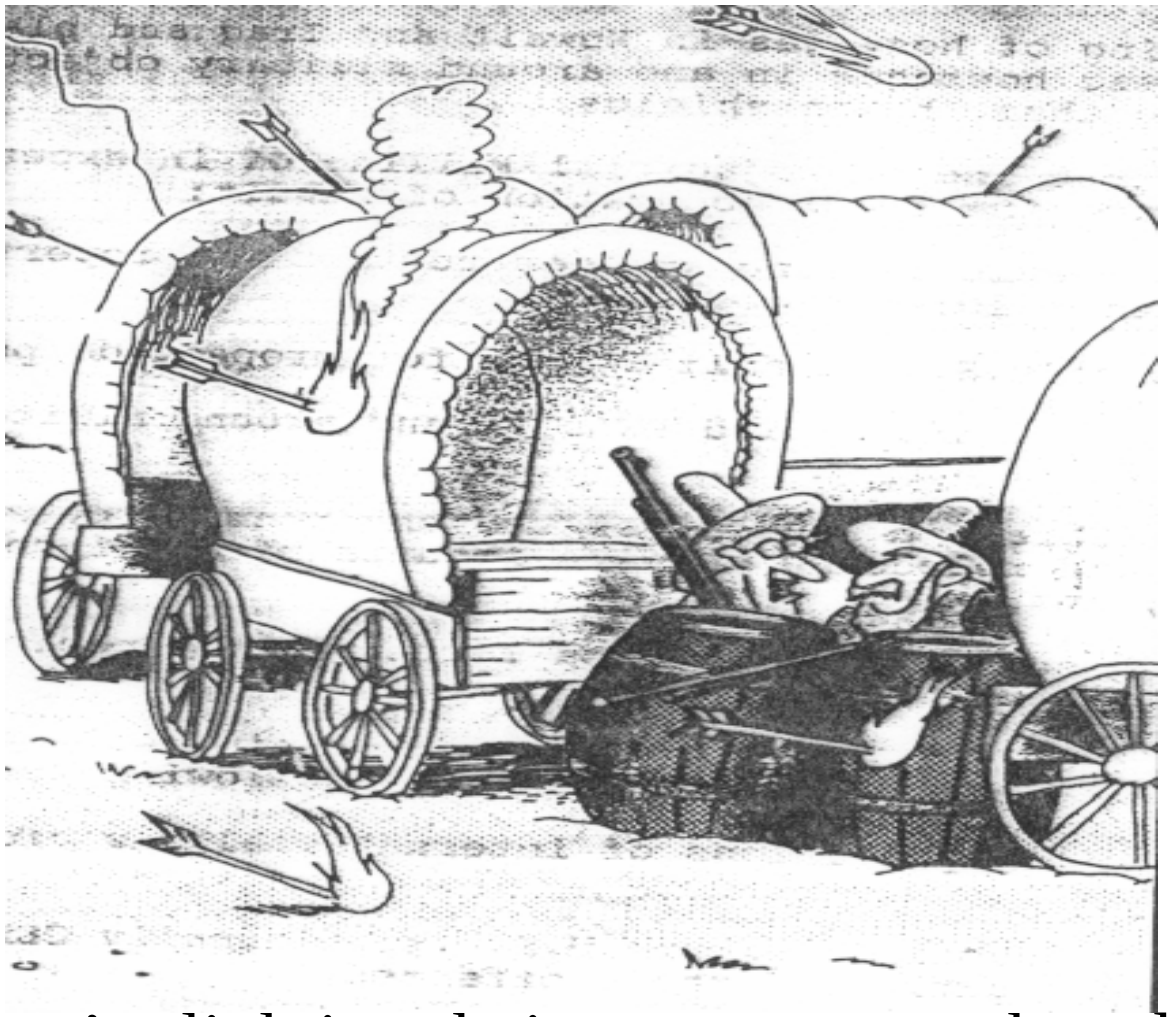
Notes:

A Concept of Operations for Armed Autonomous Systems

The difference between "Winning the War" and "Winning the Peace."

Mr. John S. Canning
Chief Engineer, G80 Division
Naval Surface Warfare Center
Dahlgren Division
(540) 653-5275
John.S.Canning@navy.mil

NAVSEA
WARFARE CENTERS
DAHLGREN



Hey, they're lighting their arrows…can they do that?

This is all about what is, and isn't, allowed under the Law of Armed Conflict (LOAC)

NAVSEA
WARFARE CENTERS
DAHLGREN

From the beginning of human history, man has been targeting his enemies with his weapons

Civil War dead

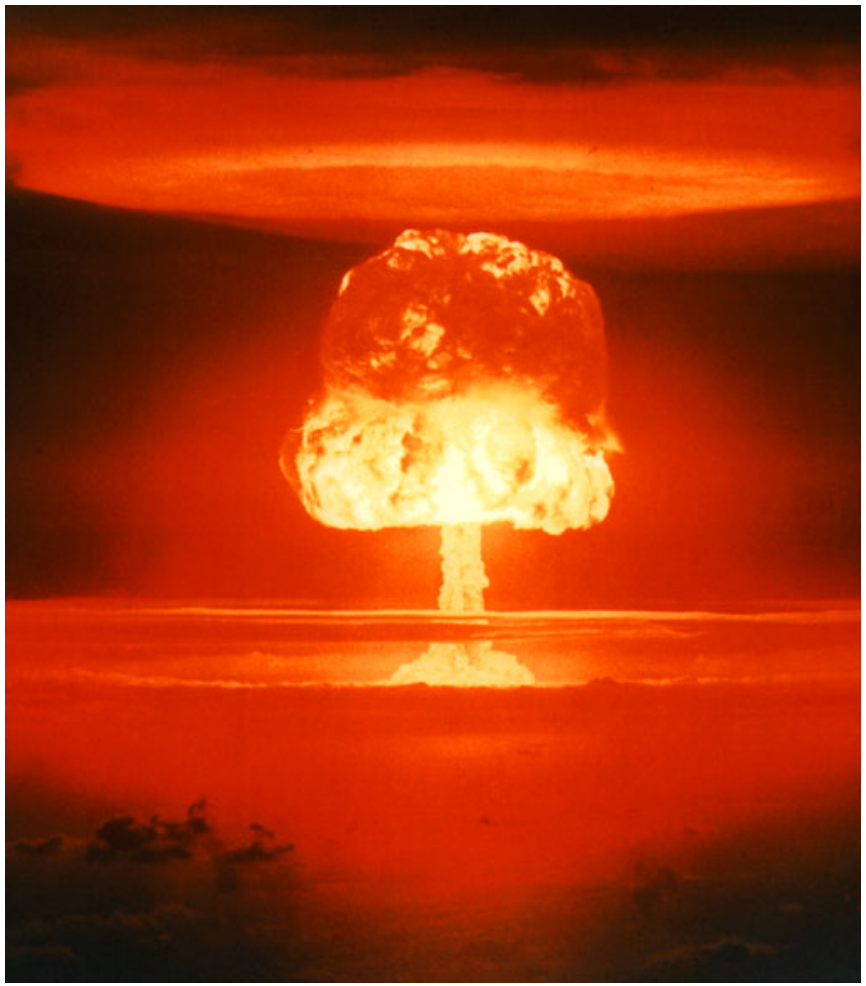
WWII Battle of the Bulge

Remembering the dead from Iraqi Freedom

How many millions have died, or been injured?

NAVSEA
WARFARE CENTERS
DAHLGREN

Under the Napoleonic Theory of War (everything is fair game), we have opted for the "bigger bang," causing potential for incidental injury to civilians and collateral damage to civilian property to increase.



An atomic blast

The atomic dome in Hiroshima, located directly under Ground Zero.

Safety of innocent civilians wasn't the greatest concern.

NAVSEA
WARFARE CENTERS
DAHLGREN

Lessons from WWII: Destruction beyond that necessary to accomplish the military objective can prolong the war, and can make securing a lasting peace more difficult.

WWII bomb damage in the German city of Dresden

German civilians in Halberstad following 8 APR 1945 bombing

TV brought the Vietnam war to the nation's living rooms, put a human "face" on the war and contributed to civil and political unrest at home

Siege at Khe Sanh – 500lb bombs falling on NVA trenches

Vietnam War protest in Washington, D.C.

"The Wall"

NAVSEA
WARFARE CENTERS
DAHLGREN

Despite man's history of violence, there have long been restrictions on the use of force during war. Today, ***treaties*** as well as the ***Law of Armed Conflict or LOAC*** regulate the use of force during armed conflict.

- Now, all weapons and weapon systems, from small arms and ammunition to cruise missiles are subjected to a legal review to ensure compliance with the Law of Armed Conflict (LOAC) and applicable treaties.

- Additionally, once declared legal, the employment of these weapons may be further controlled by ***Rules of Engagement*** and the ***Discriminate Use of Force***

Legal Review of Weapons

- DoD policy requires that a legal review be conducted of all weapons and weapon systems acquired to meet a military requirement of the US.
- Primarily this review requires an analysis of three factors:

  (1) whether the weapon causes suffering that is needless, superfluous, or disproportionate to the military advantage reasonably expected from the use of the weapon. It cannot be declared unlawful merely because it may cause severe suffering or injury;

  (2) whether the weapon is capable of being controlled so as to be directed against a lawful target, (i.e., it can ***discriminate*** between lawful and unlawful targets);

  (3) whether there is a specific treaty provision or domestic law prohibiting the weapon's acquisition or use.

- These three factors are analyzed in relation to the weapon's intended method of employment, not in relation to any possible use, as any lawful weapon can be used illegally.

With regard to Armed Autonomous Systems, the critical issue is the ability for the weapon to discriminate a legal target

Rules of Engagement Defined

- Directives issued by competent authority which delineate the circumstances and limitations under which U.S. forces will initiate and/or continue combat engagement with other forces encountered.

  Joint Pub 1-02

- ROE are based on the LOAC as well as political and military factors and can be utilized to guide the military use of force during a particular operation.

ROE can restrict the employment of certain weapons depending on the tactical, strategic or political situation.

NAVSEA
WARFARE CENTERS
DAHLGREN

Discriminate Use of Force (DUF)

- "Our concept of DUF strongly aligns with much of the current thinking about effects-based operations (EBO). The coming of age of these concepts is influenced both by *opportunity* and *need*.
- DUF brings new concepts for collaboration and massing of effects, which are joint in character and integrated among joint force echelons and components. It is enabled by new weapons; improved intelligence, surveillance, and reconnaissance; shared situation understanding; improved individual and collaborative training; greater agility; smaller footprints; and other emerging capabilities of the U.S. military that allow more timely and precise use of force than heretofore possible.
- *The need* is driven by the nature of current military campaigns. A striking feature of these campaigns is the tension among multiple strategic and operational objectives: cause regime change, destroy a terrorist organization, decapitate leadership, but preserve infrastructure, don't wage war on a people, do hold an international coalition together, etc."

"Report of the Defense Science Board Task Force on Discriminate Use of Force," JUL 2003

Driven by new technology yielding better discrimination, which leads to demand for even better technology

NAVSEA
WARFARE CENTERS
DAHLGREN

The Issue

- Using today's paradigm of warfare, there is a requirement to maintain an operator in the "weapons release"-loop to avoid the possibility of accidentally killing someone.
- An operator is effectively "welded" to each armed unmanned system for this purpose.
- This is a "performance- and cost-killer" when considering the employment of large numbers of armed unmanned systems

How can we effectively employ armed unmanned systems, while avoiding this problem?

NAVSEA
WARFARE CENTERS
DAHLGREN

Target Discrimination:
How do you tell the difference?

Between a cruise ship…

Between people who are just mad at you…

…and a war ship?

…and a determined enemy?

NAVSEA
WARFARE CENTERS
DAHLGREN

What we want to avoid…

This is your worst nightmare!
It is a safety issue concerning the innocents of war.

NAVSEA
WARFARE CENTERS
DAHLGREN

A Proposed Concept of Operations (CONOPS) for Autonomous Use of Weapons

- **Let the machines target other machines**
  - Specifically, let's design our armed unmanned systems to automatically ID, target, and neutralize or destroy the weapons used by our enemies – not the people using the weapons.
  - This gives us the possibility of disarming a threat force without the need for killing them.
  - We can equip our machines with non-lethal technologies for the purpose of convincing the enemy to abandon their weapons prior to our machines destroying the weapons, and lethal weapons to kill their weapons.
- **Let men target men**
  - In those instances where we find it necessary to target the human (i.e. to disable the command structure), the armed unmanned systems can be remotely controllable by human operators who are "in-the-weapons-control-loop"
- **Provide a "Dial-a-Level" of autonomy to switch from one to the other mode.**

This CONOPS may overcome some of the political objections and legal ramifications of the use of Armed Autonomous Systems

NAVSEA
WARFARE CENTERS
DAHLGREN

Valid Targets from a Legal Standpoint

People

Things	Not a Military Objective	Valid Military Objective
Not a Military Objective	Can't Target	Target People
Valid Military Objective	Target Things	Target All

"We can target objects when they are military objectives and we can target people when they are military objectives. If people or property isn't a military objective, we don't target it. It might be destroyed as collateral damage, but we don't target it. Thus in many situations, we could target the individual holding the gun and/or the gun and legally there's no difference." – MAJ R. Craig Burton, USAF, Judge Advocate General's Legal Center and School

NAVSEA
WARFARE CENTERS
DAHLGREN

Target Subset for Autonomous Systems

		People	
		Not a Military Objective	Valid Military Objective
Things	Not a Military Objective	Can't Target	Won't Target
	Valid Military Objective	Target Things	Target Things, but Not People

For autonomous systems, we are purposefully restricting the target set.

NAVSEA
WARFARE CENTERS
DAHLGREN

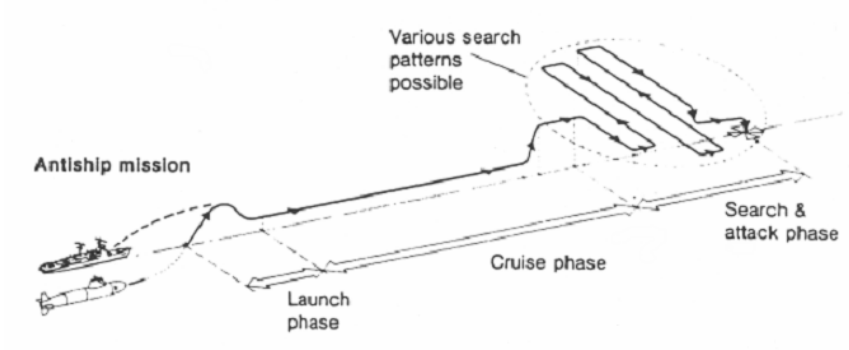
Legal Precedence Established

- TOMAHAWK Anti-Ship Missile
  - Passive Identification/Direction-Finding Equipment
- CAPTOR Mine
  - “Mousetrap that chases the mouse”
- AEGIS Ships
  - “Auto-Special” Engagement Mode
- Close-In Weapon System
  - Automatic Cruise Missile Defense
- Patriot Missile System
  - Automated air defense

Each of these directly targets either the bow, or the arrow, but not the archer. People may still die, but as a secondary consequence of going after the weapon of war.

Tomahawk Anti-Ship Missile
1983 to about 1992

PI/DE Capability



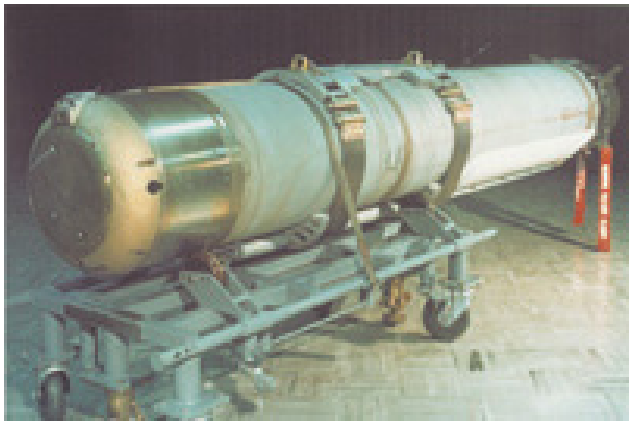
From "The Commander's Handbook on the Law of Naval Operations," NWP 1-14M

9.9 OVER-THE-HORIZON WEAPONS SYSTEMS

Missiles and projectiles with over-the-horizon or beyond-visual-range capabilities are lawful, provided they are equipped with sensors, or are employed in conjunction with external sources of targeting data, that are sufficient to ensure effective target discrimination.

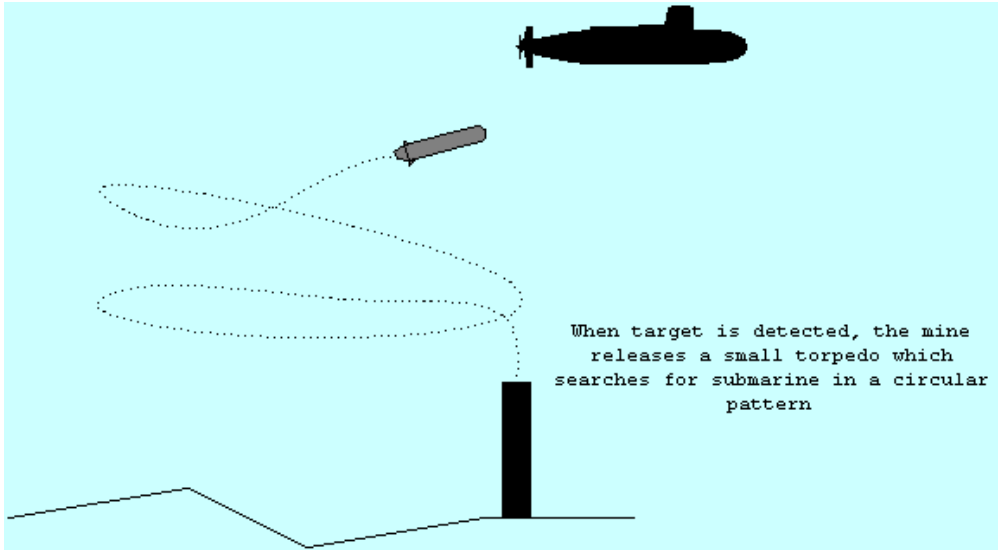
The missile is launched in the general direction of the target and at some distance from the expected target position, it enters a serpentine flight pattern to search for it using both passive radar to scan enemy emissions and active radar to lock on a detected target.

CAPTOR Mine System
1979- 2000



The mousetrap that chases the mouse

CAPTOR acoustically detects submarines while ignoring surface ships. Upon detection of a target, the mine launches an acoustic homing Torpedo Mk 46 Mod 6.



NAVSEA
WARFARE CENTERS
DAHLGREN

AEGIS Auto-Special Doctrine
1973-Present

AEGIS Auto-Special Doctrine allows “hands-off” engagement of AAW threats completely from initial detection to kill assessment, and the decision to re-engage, if necessary.

NAVSEA
WARFARE CENTERS
DAHLGREN

Close-In Weapon System
1980- Present

The MK 15 Phalanx Close-In Weapons System is a fast-reaction, rapid-fire 20-millimeter gun system that provides US Navy ships with a terminal defense against anti-ship missiles that have penetrated other fleet defenses. Designed to engage anti-ship cruise missiles and fixed-wing aircraft at short range, Phalanx automatically engages functions usually performed by separate, independent systems such as search, detection, threat evaluation, acquisition, track, firing, target destruction, kill assessment and cease fire.

NAVSEA
WARFARE CENTERS
DAHLGREN

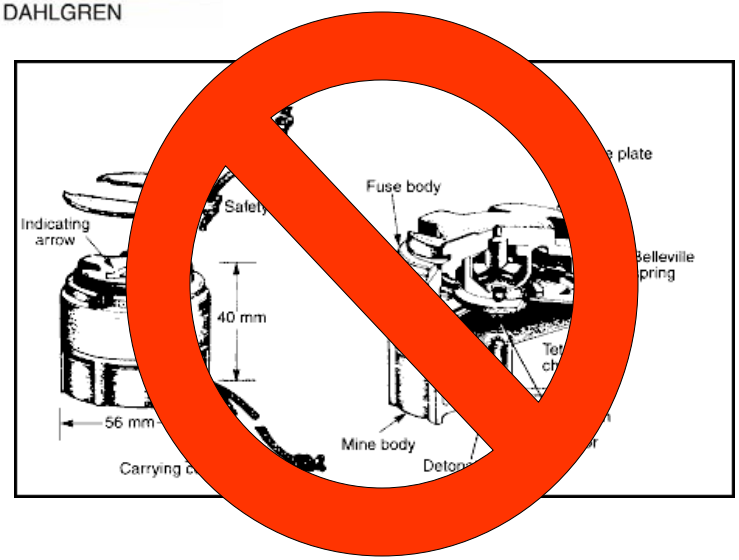
Patriot Missile System
1984- Present

“An incoming missile could be 50 miles (80.5 kilometers) away when the Patriot's radar locks onto it. At that distance, the incoming missile would not even be visible to a human being, much less identifiable. It is even possible for the Patriot missile system to operate in a completely automatic mode with no human intervention at all. An incoming missile flying at Mach 5 is traveling approximately one mile every second. There just isn't a lot of time to react and respond once the missile is detected, making automatic detection and launching an important feature.”

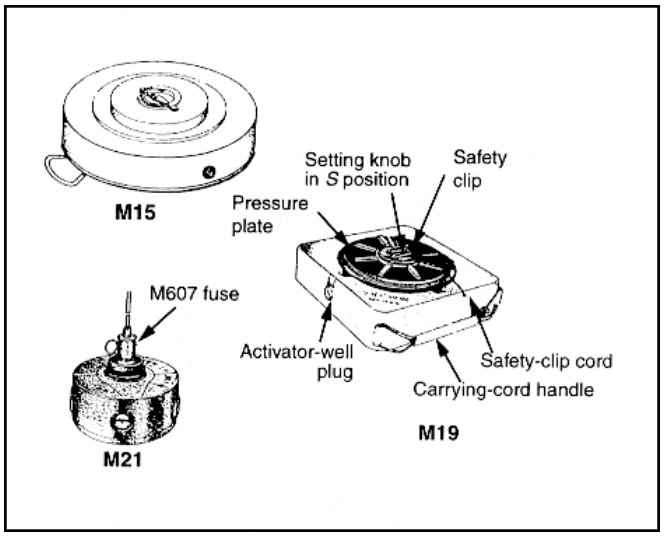
http://science.howstuffworks.com/patriot-missile.htm

NAVSEA
WARFARE CENTERS
DAHLGREN

A Relevant Dichotomy



Anti-Personnel Landmines



Anti-Tank Landmines

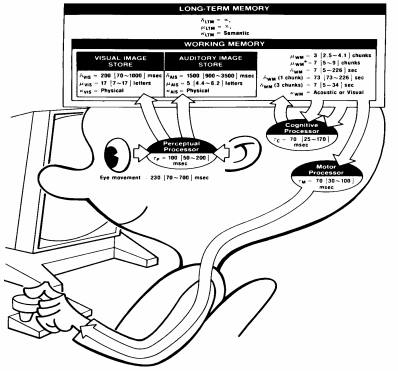
There is a huge international debate over the continuing use of Anti-Personnel Landmines, with most of the world abandoning their use. The single essential of the problem is the fact that conventional Anti-Personnel Landmines are designed to persist, remaining lethal for decades after they are emplaced. This then becomes a long-term issue for civilian populations living in the areas that were mined. There is not the same level of debate over the use of Anti-Tank Landmines.

This highlights the issue of targeting the archer, as opposed to his bow, or arrow.

NAVSEA
WARFARE CENTERS
DAHLGREN

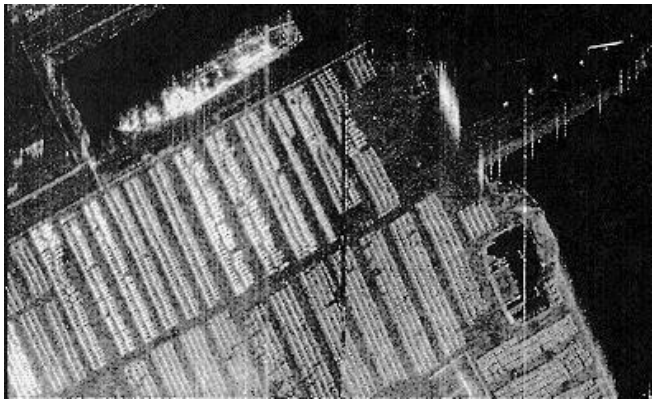
CONOPS-Enabling Technologies

- Sensors
- Artificial Intelligence
- Communications
- Protection
- Stabilized weapons
- Data recording



Sensors

- "DC to Daylight"
  - Broad spectrum coverage
  - Detect the presence of weapons
- Radar
  - Imaging
  - Robust
  - Enable target discrimination
    - Distributed Imaging Radar Technology (DIRT)
- Optical
  - IR
  - Low Light Level
  - "All-weather" capability
- Other
  - ?
- No single "Silver Bullet" sensor
  - Likely will need a combination of sensors



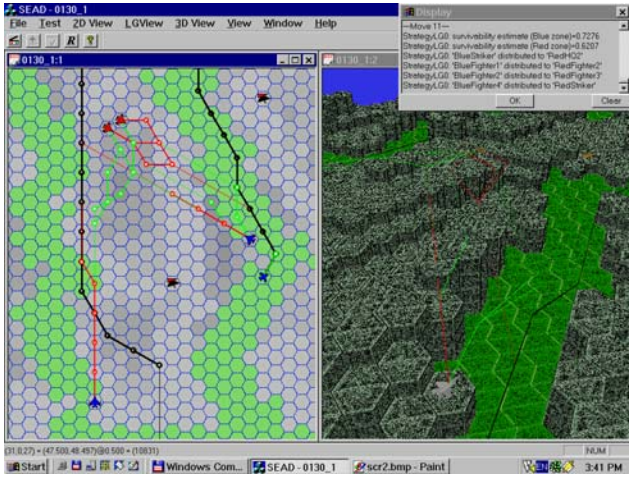
Imaging Radar

Night Vision

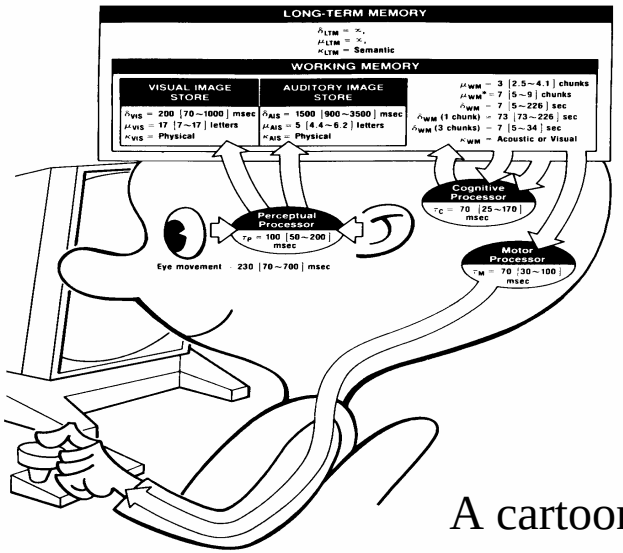
IR Image

Artificial Intelligence

- Situational Awareness
  - Sensor fusion
- Efficient battlefield search for weapons
- ID weapons as weapons
  - Automatic Target Recognition
  - Share information about new weapons with others
- Communicate to enemy that his weapon is being targeted
  - Give him the opportunity to abandon his weapon
- “Dial-a-Level” of autonomy
- Select correct weapon(s) for use
- Target/track enemy weapons
- Engage enemy weapons
- Swarm behavior
  - Self-coordinating



Linguistic Geometry



A cartoon for AI

Communications

- Provide Common Relevant Operational Picture (CROP) input to the Command Structure
- Local coordinating communications among other unmanned systems
- “Skip echelon” capability
- Secure
  - LPI/LPD
  - Encryption
- High bandwidth
  - HDTV
- Communicate with the enemy

Long-Range Acoustic Device

Navy Combat Information Center

Protection

- Expect to draw fire
  - Remember, we will be using COTS gear
  - Be prepared for it
- Armor
  - Passive (i.e. Kevlar)
  - Active (i.e explosive)
- Use redundant & dispersed components
- Active defenses
  - Take out the source of incoming fire
    - Hostile intent is already established
    - Kill the source
  - Take out the incoming fire itself
    - Wolfpack Electronic Attack System
    - FCLAS counter-RPG system
  - Self-repairing materials

Ye olde armor

FCLAS counter-RPG System

Wolfpack Electronic Attack System

Stabilized Weapons

- Shoot faster and straighter than a human
- Target the enemy's weapons
- Stay inside the enemy's OODA loop
- Non-lethals needed to separate human from his weapons
  - Active Denial technology
- Lethals needed to destroy weapons
  - Lethal to weapons
  - Traditional lethals
    - Guns
    - Missiles
  - Unconventional lethals
    - Directed Energy Weapons

Ship-mounted stabilized guns

Active Denial ACTD

Data Recording

- What happens if the enemy spoofs our armed unmanned systems, and causes them to kill when they shouldn't?
  - Political support can disappear virtually instantaneously
- Law enforcement departments equip today's police cruisers with video cameras and recorders to provide evidence of what happens during routine traffic stops.
- Need to record, and download, sensor data from our unmanned systems leading up to, and encompassing, engagements so that we have a record of any attempts at spoofing.
- Supplies direct evidence of enemy guilt

From a police video of a traffic stop

NAVSEA
WARFARE CENTERS
DAHLGREN

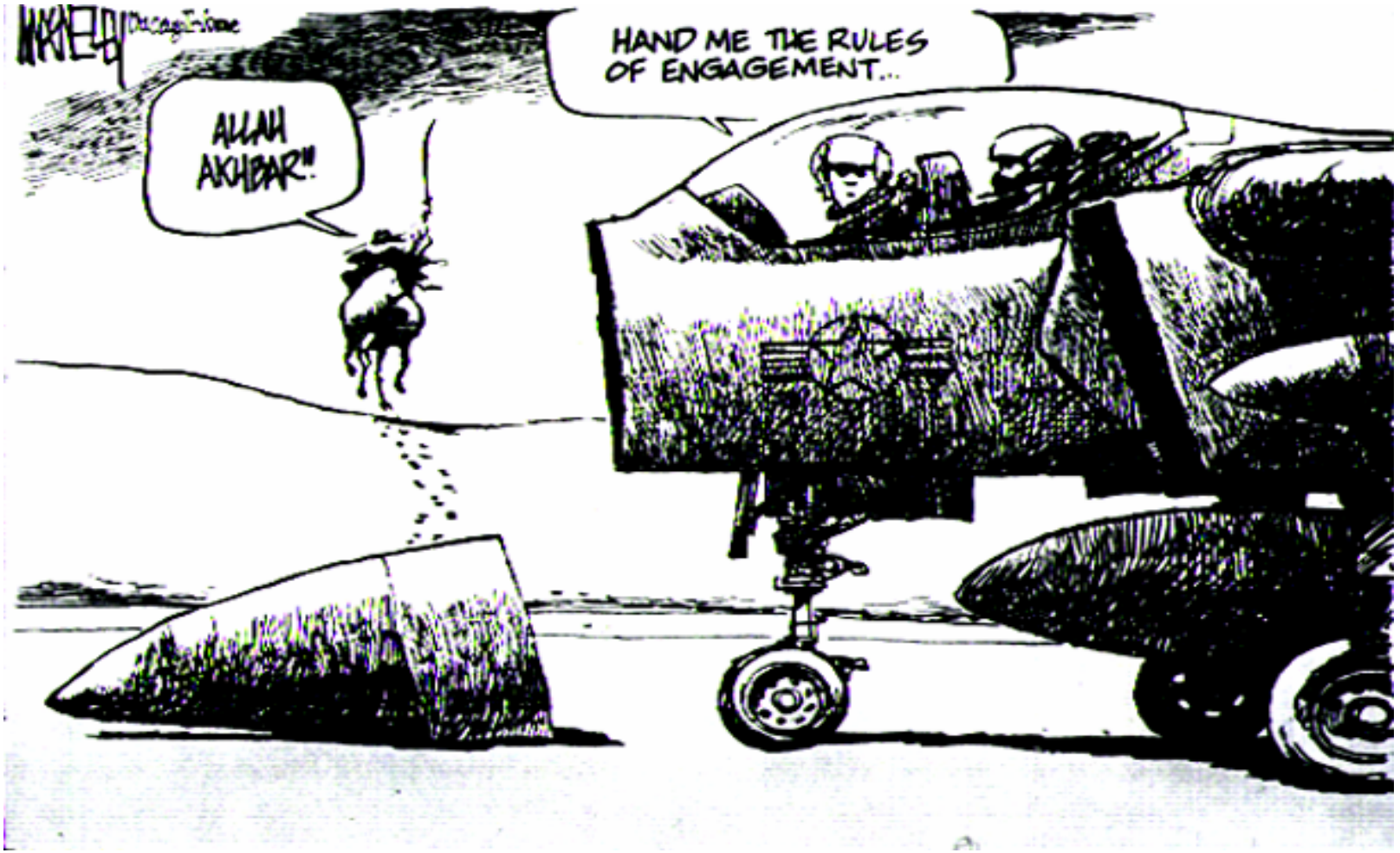
Summary

- Unfettered death and destruction (particularly of civilians and civilian property), can impair the restoration of a lasting peace. Real-time media coverage has brought the destruction of war to the "living room" and has added to the political reactions and a possible perception of excessive civilian causalities.
- This has driven strong adherence to LOAC considerations for *all* weapons. The LOAC has evolved to prevent needless death and destruction and most nations now utilize ROE as further measure to control the use of force.
- The use of armed unmanned systems offers us the opportunity to break this centuries-old paradigm of warfare, if we design them to target an enemy's weapons instead of the people who are employing them. Legal precedent has been set.
- An enemy would then have a choice of abandoning his weapon and living, or continue using it, and dying.
- The widespread utilization of armed fully autonomous unmanned systems will be impossible, from cost and performance standpoints, without it.
- The development of a number of technologies would help to support such a CONOPS:
  - Sensors
  - Artificial Intelligence
  - Communications
  - Protection
  - Stabilized weapons
  - Data recording

Let the machines target machines – not people

NAVSEA
WARFARE CENTERS
DAHLGREN

A Parting Shot



Technology Surprise—Why should we worry?

Ruth David

6 September 2006

Tech Surprise: Why worry?

Surprise is the most essential factor of victory . . .

nothing makes a leader greater than
the capacity to guess the designs of the enemy . . .

to recognize, to grasp the situation & take advantage of it as it arises . . .

new and sudden things catch armies by surprise.

Niccolo Machiavelli,
The Art of War, 1520

Our military forces—and our adversaries—are increasingly enabled by technology.

Perspective/Background

- Committee on DIA Technology Forecasts and Reviews
  - Ad hoc committee (1-year) of the National Research Council
  - Sponsored by DIA's Technology Warning Division
  - "Avoiding Surprise in an Era of Global Technology Advances"
- Committee on Technology Insight-Gauge, Evaluate, and Review (TIGER)
  - Standing Committee of the National Research Council
  - Sponsored by Defense Intelligence Agency

Will NOT try to predict what technologies may be disruptive!

"Avoiding Surprise . . ."

- Finding 1: There is a multitude of evolving technologies for which advances are being driven by the nongovernmental, global, scientific and technical communities.
  - New/different players . . . new/different motivations
- Finding 2: New intelligence indicators are likely to be needed to provide technology warning for the diverse spectrum of evolving technologies that are being driven by commercial forces in the global marketplace.
  - New potential sources and new observables
- Finding 3: The landscape of potentially important evolving technologies is both vast and diverse.
  - Emerging technologies . . . innovative integrations

Potential for surprise is growing—that's why we should be worried!

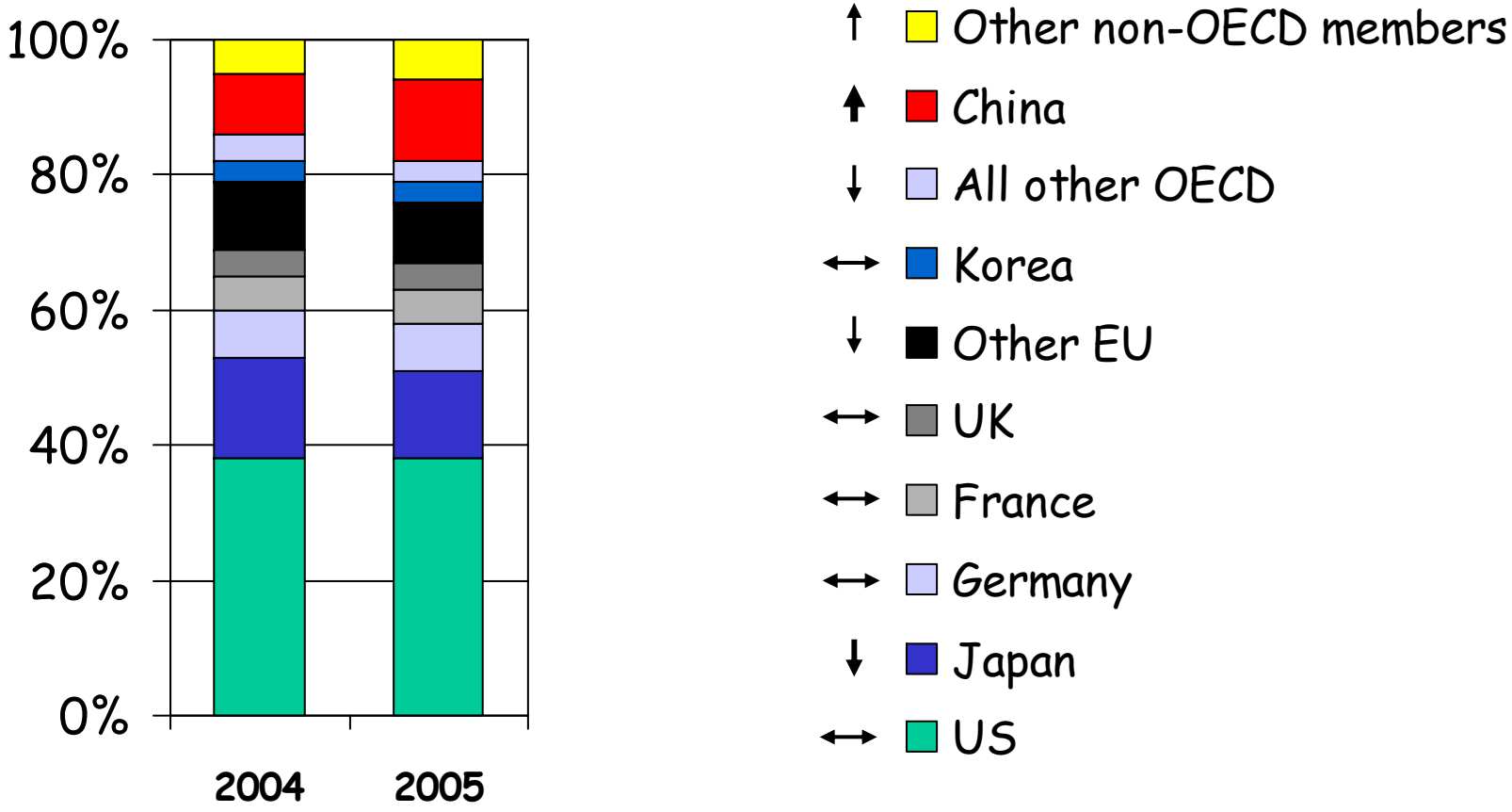
Changing Nature of Defense Technology (Carter etal. 2000)

Cold War	→	Future
Defense Technology		*Defense Technology*
Originates in defense technology base	→	Originates in commercial technology base
that is embedded in defense companies	→	that is embedded in commercially driven companies
residing in the US	→	that are global
for which defense is main driver.	→	for which defense is niche player.

Question: Is the "Future" here today?

International R&D Investment

Shares of Total World R&D

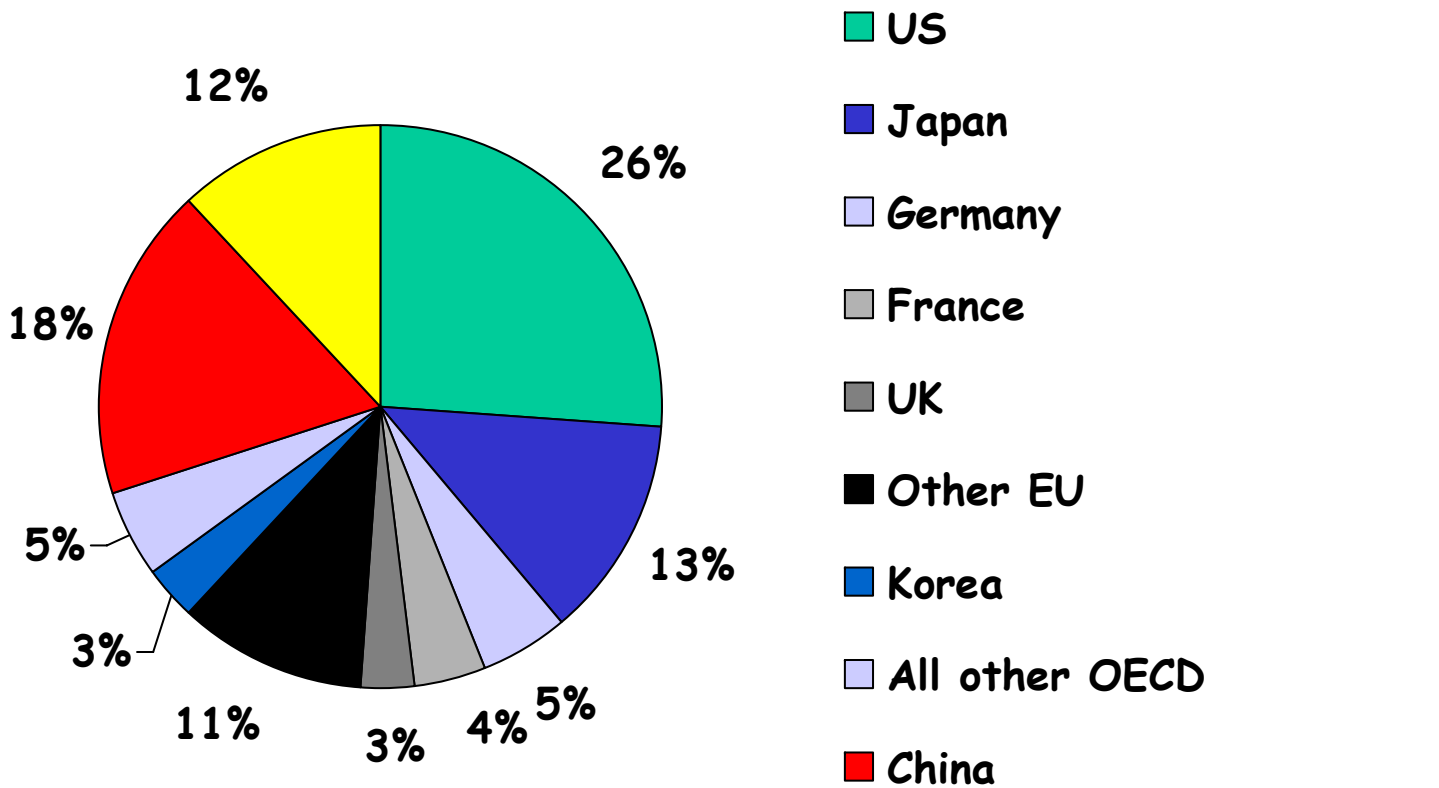


Source: OECD, Main Science and Technology Indicators. 2004 (2003 data); 2005 (2004 data). AAAS Website. Total World R&D increased from $764B to $836B during period.

US still dominates but other nations' shares have changed dramatically.

International R&D Performance

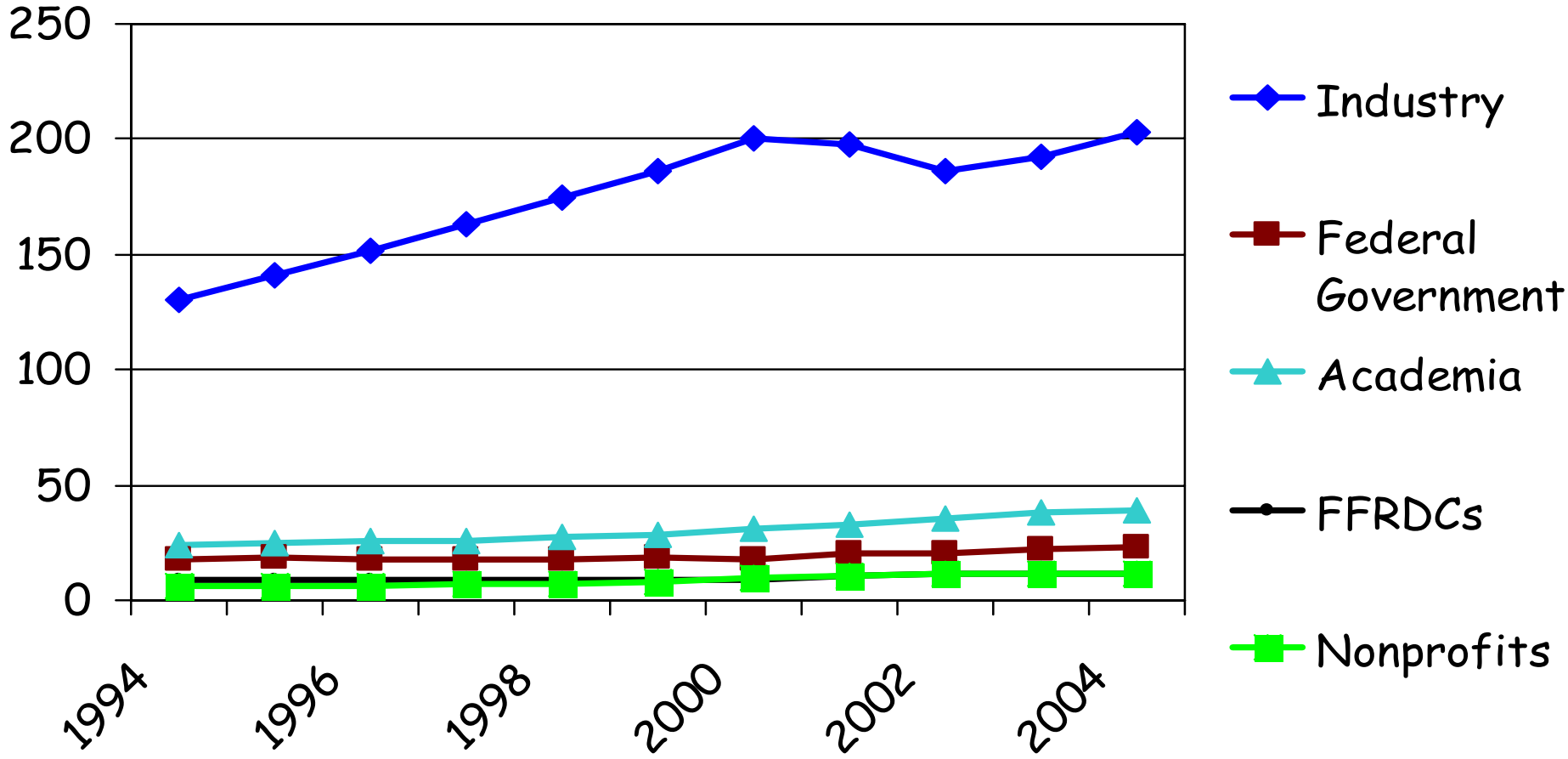
Shares of World S&E Researchers, 2003



Source: OECD, Main Science and Technology Indicators. AAAS Website

US also dominates R&D performance, but the gap is narrower.

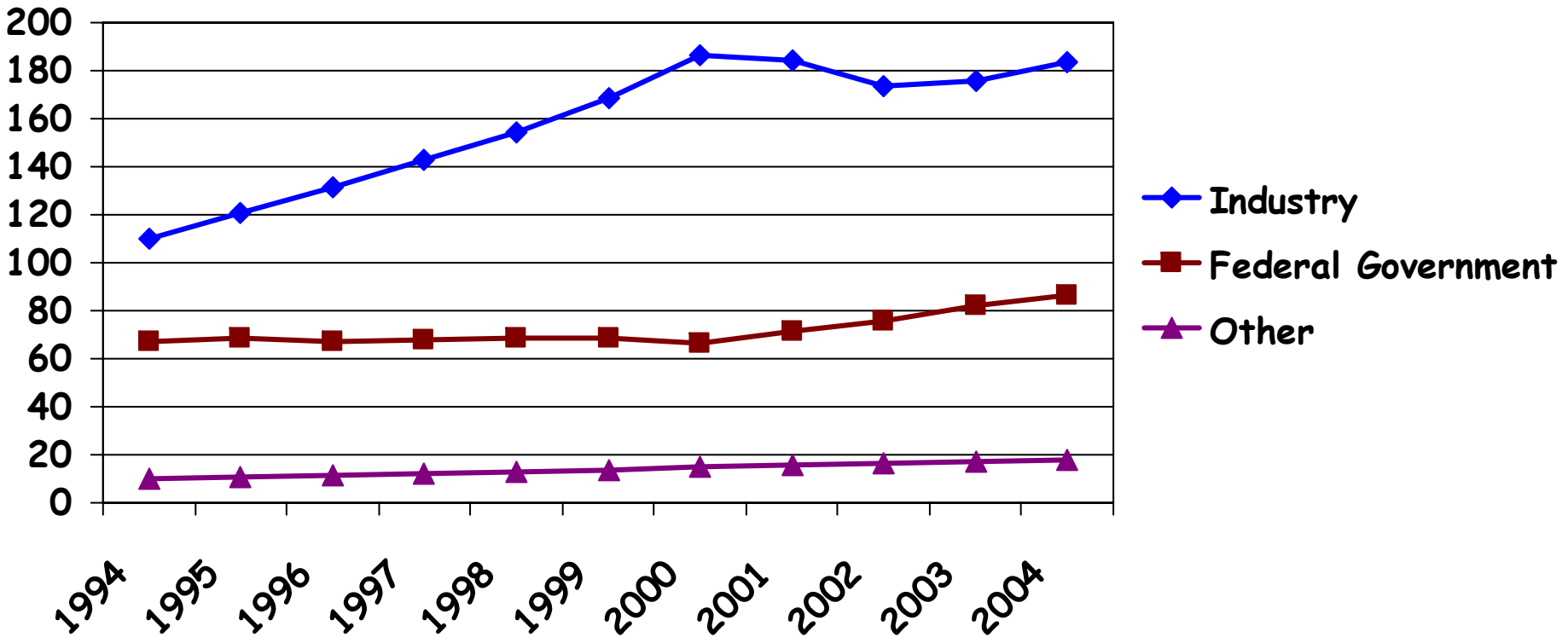
US R&D by Performing Sector



Source: National Science Foundation/Division of Science Resources Statistics, National Patterns of R&D Resources. Constant 2000 dollars (billions).

Industry dominates performance of research & development in the US.

US R&D by Funding Sector



Source: National Science Foundation/Division of Science Resources Statistics, National Patterns of R&D Resources. Constant 2000 dollars (billions).

Industry also dominates funding of research & development in the US.

"Avoiding Surprise . . ."

- New/different players . . .new/different motivations
  - Recommendation 1: . . . establish an ongoing collaborative relationship with scientific and technical communities in the industrial and academic sectors.
- New potential sources and new observables . . .
  - Recommendation 2: . . . establish, maintain, and systematically analyze a comprehensive array of indicators pertaining to globalization and commercialization of science and technology to complement and focus intelligence collection and analysis.
- Emerging technologies . . . innovative integrations
  - Recommendation 3: . . . adopt a capabilities-based framework within which to identify and assess potential technology-based threats.

Committee strongly encouraged increased attention to this growing challenge.

Observation

- NDIA/ODDR&E: 6-7 September 2006
  - "Seeking the Capability Before the Capability is the Surprise"
- S&T Surprise Working Group: 11-12 October 2006
  - Symposium: The Electronic Environment
- Wright Patterson AFB: 17-19 October 2006
  - "Disruptive Digital Technology—Avoiding Tech Surprise"
- IC/National Labs: 14-16 November 2006
  - Emerging Technologies and Avoiding Tech Surprise

Concern/focus is evident within the National Security community.

Sage advice from 1976 . . .

- "Guarding Against Technological Surprise"
  - Dr. George Heilmeier

- "The real difference between the surpriser and the surprised is usually not the unique ownership of a piece of new technology."

- "The key difference is in the recognition or awareness of the impact of that technology and decisiveness in exploiting it."

Source: www.airpower.maxwell.af.mil/airchronicles/aureview/1976/sep-oct/

Recall Machiavelli!

For your consideration . . .

- Maintain the technological initiative.
- Ensure that intelligence is timely.
- Develop options.
- Develop mechanisms that provide for an orderly response when a technological surprise suddenly appears.
- Make tactical and doctrinal flexibility part of our training and test and evaluation processes.
- Create an atmosphere of cooperation and exchange between technologists and commanders of real forces.
- Finally, make sure that there will be a close working relationship between defense-oriented scientists and engineers and their colleagues in the industrial and in the university technical communities.

Heilmeier: Steps which a free society can take to prevent technological surprise.

The bottom line . . .

The challenge of avoiding technology surprise is not new

but success in the 21st century

will require new thinking and new partnerships.

US has no monopoly on either technological advances or disruptive innovations.

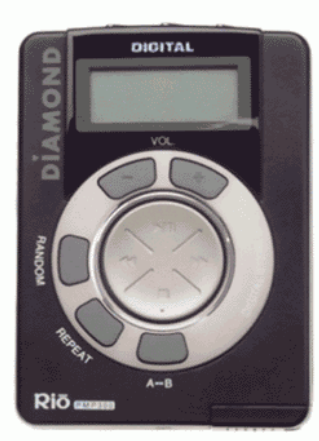
INNOSIGHT
unlocking new market growth

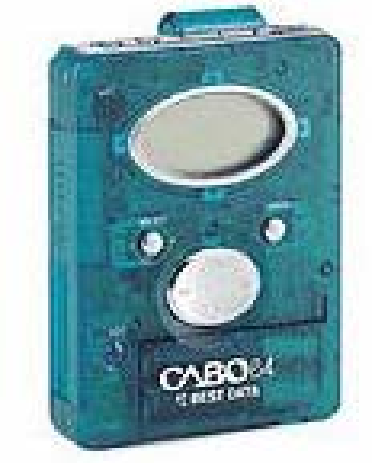
Succeed in Disruptive Technologies by Succeeding in Innovation

3rd Annual Disruptive Technology Conference

Washington, DC | September 7, 2006

The MP3 revolution





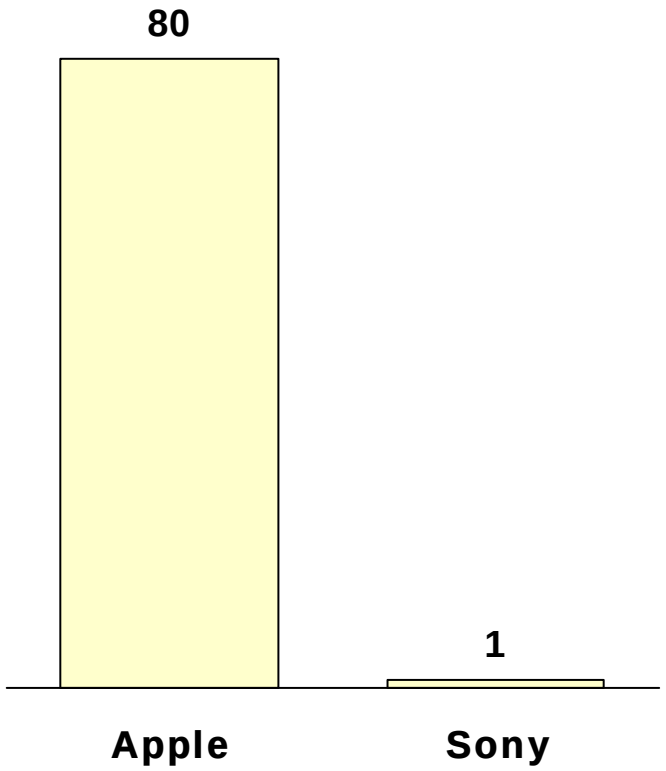
1998	2000	2002	2003	2005
15%	3%	-7%	-7%	??

Annual Growth in CD sales ($)

Source: RIAA Web Site; Innosight Analysis

Where's Sony?

Share of MP3 player market
% 2004



"I think we fell asleep for a while … Maybe part of [the problem] was being affiliated with a music company."

— Sony Executive
CNN/Money, 2004

"I don't really like hard disks – they're not Sony technology. As an engineer, they're not interesting."

— Sony Engineer,
WSJ, 2004

Source: Literature Search; Analyst Reports; Innosight analysis

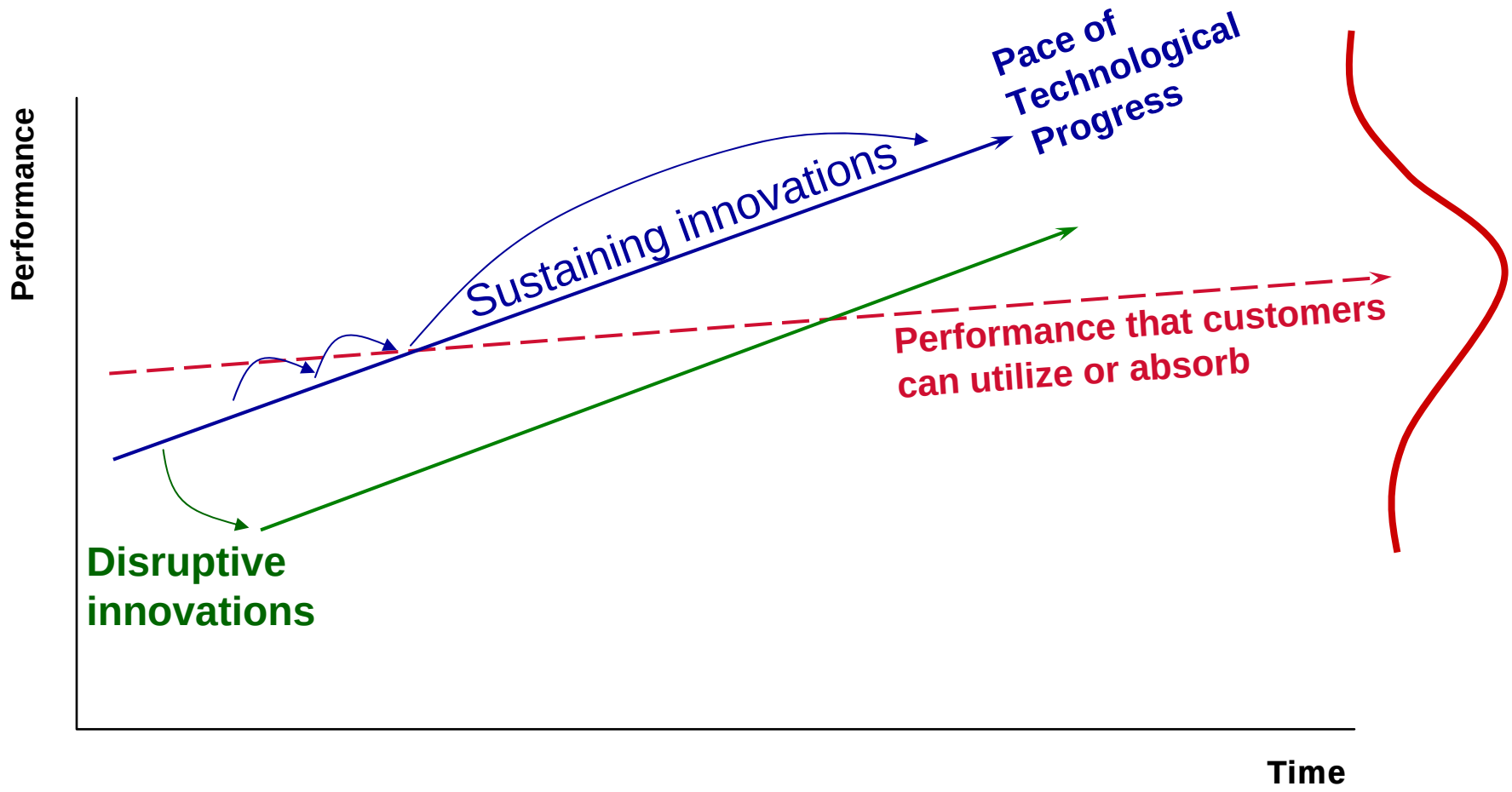
Innovation is More Than Technology

Dell: New process

iTunes: New service

MinuteClinic: New business model

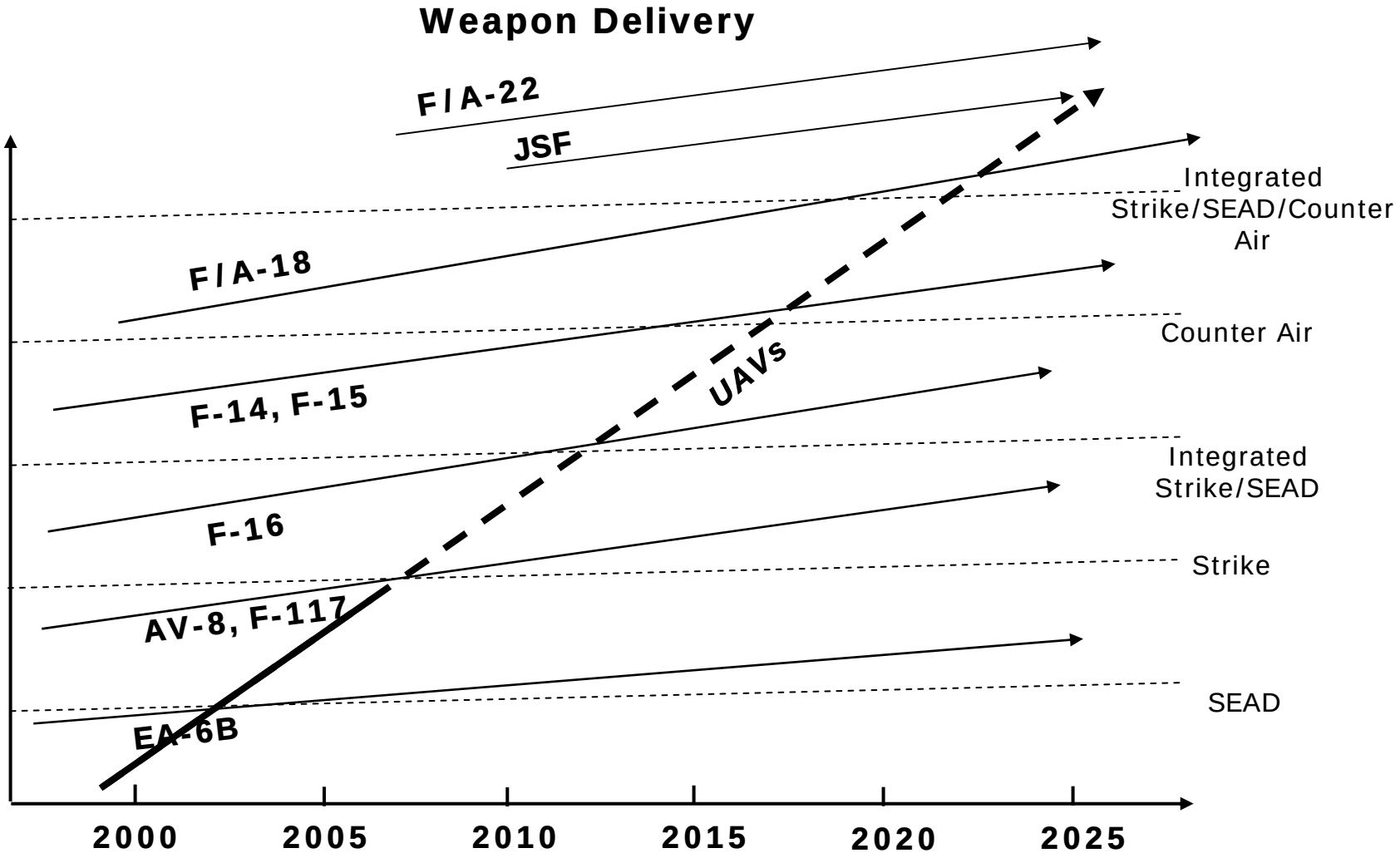
Sustaining versus Disruptive Innovation



Adjectives That Describe Different Types of Innovation

Sustaining Innovation	**Disruptive Innovation**
• Better	• Different
• Next-generation performance	• "Good enough" performance
• Great leap forward	• Great leap downwards
• Complicated	• Simple

UAVs – Addressing the Low End?

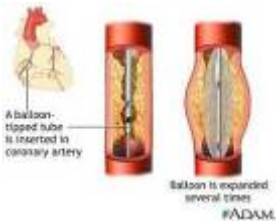


Source: OSD UAV Roadmap, 2002

Disruptive Innovations that Democratize and Decentralize

1) Is consumption of a product or service limited to the wealthy?

2) Do you have to have special expertise in order to consume (or produce)?

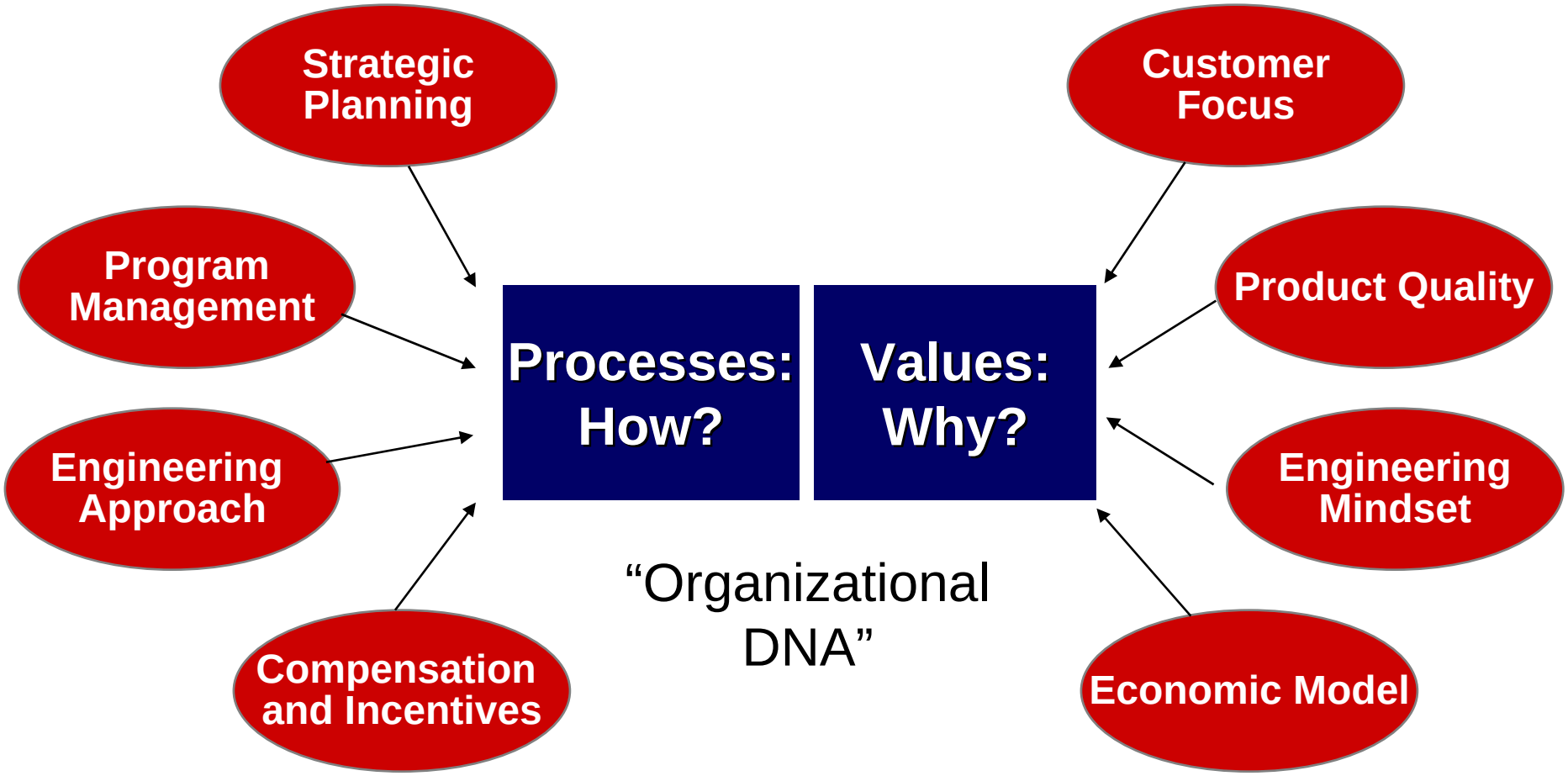


3) Does the need to go to a centralized, inconvenient location limit consumption?

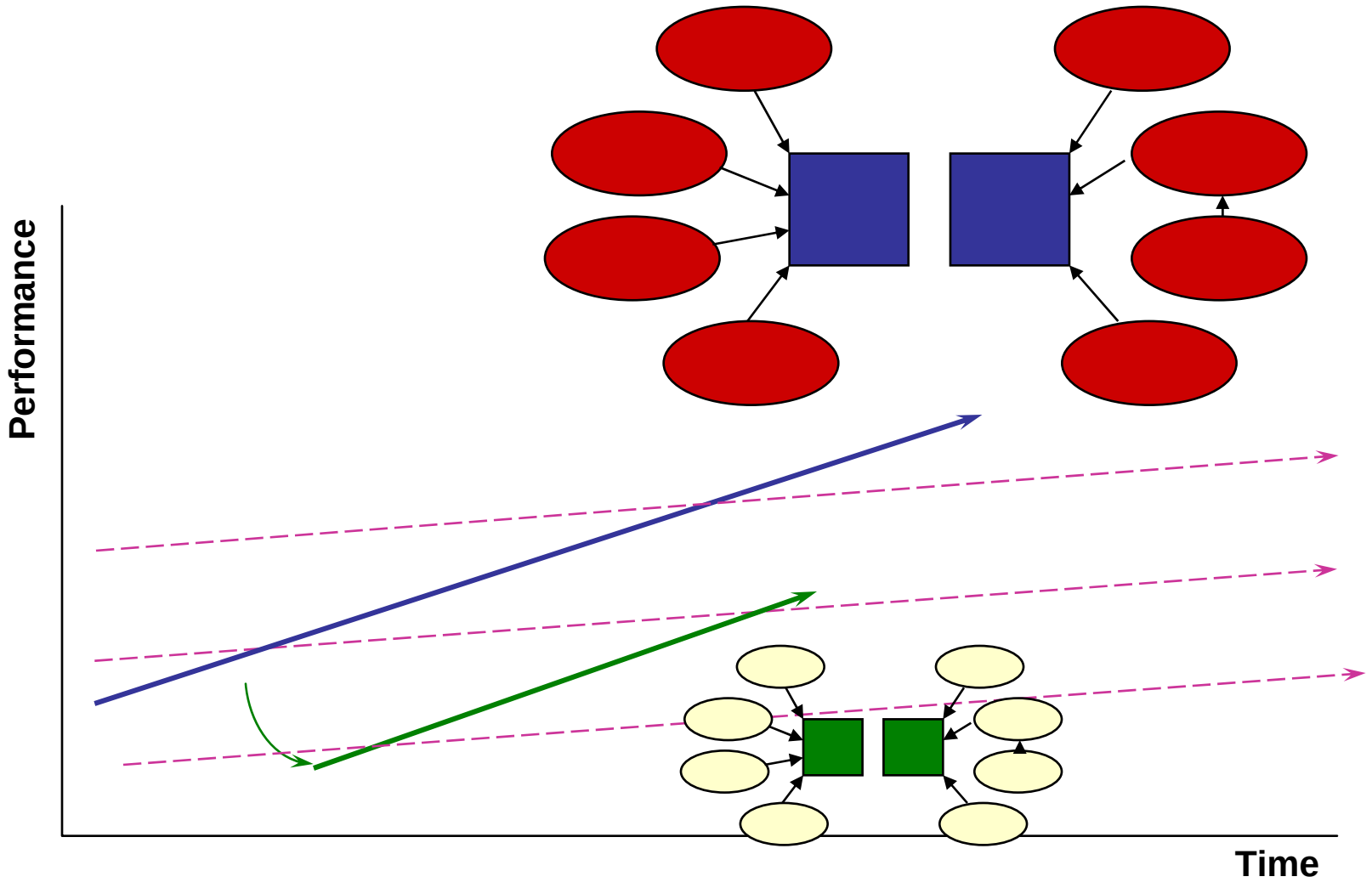
What Makes These Innovations Hard For Established, Incumbent Institutions

Resources	Processes	Values
• People • Technology • Products • Equipment • Information • Cash • Brand • Distribution	• Hiring & Training • Product development • Manufacturing • Planning & Budgeting • Market Research • Resource allocation	The criteria by which prioritization decisions are made • Ethics • Customer focus • Engineering Mindset • Economic Model

Strengths in One Context Are Often Weaknesses in Another

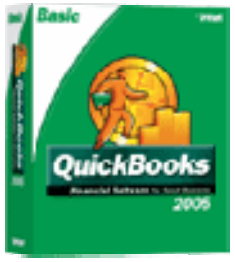


Set Up the Right Processes and Values Appropriate to the Circumstance



Focus on the ‘job’ to be done

“Kill small snippets of time productively”



“Make sure I don’t run out of cash”

- Consumer is looking for a quarter inch hole, not a quarter inch drill
- Focus on the circumstances over the demographics
- Close observation and deep interactions with consumers can be key way to find target jobs
- Beyond “voice of the customer”: “If I'd listened to customers, I'd have given them a faster horse” – Henry Ford

Get the ‘gives’ and ‘gets’ right

Vs.

Don’t introduce the FunSaver

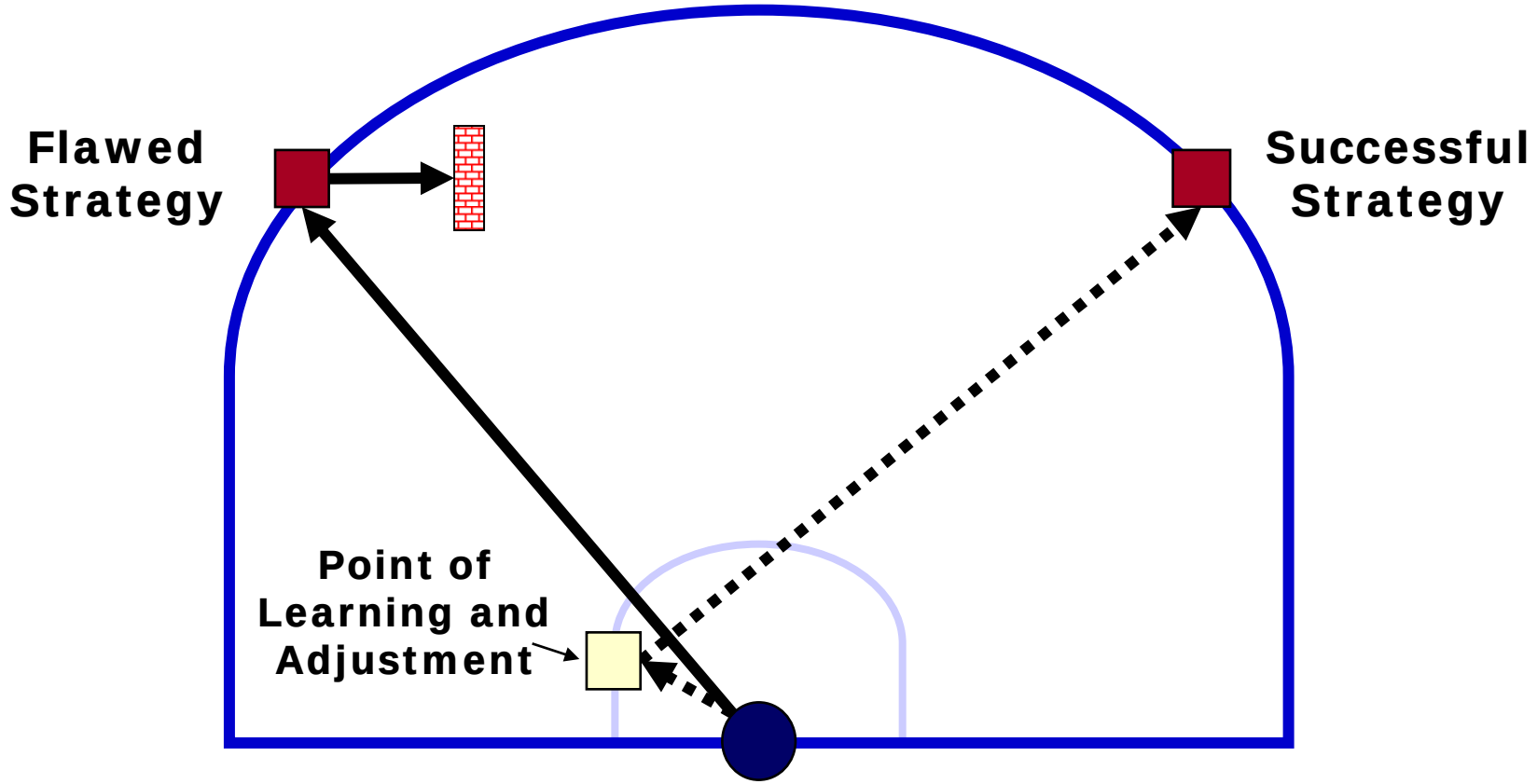
Vs.

At Disney World … forgot my camera

Introduce the FunSaver

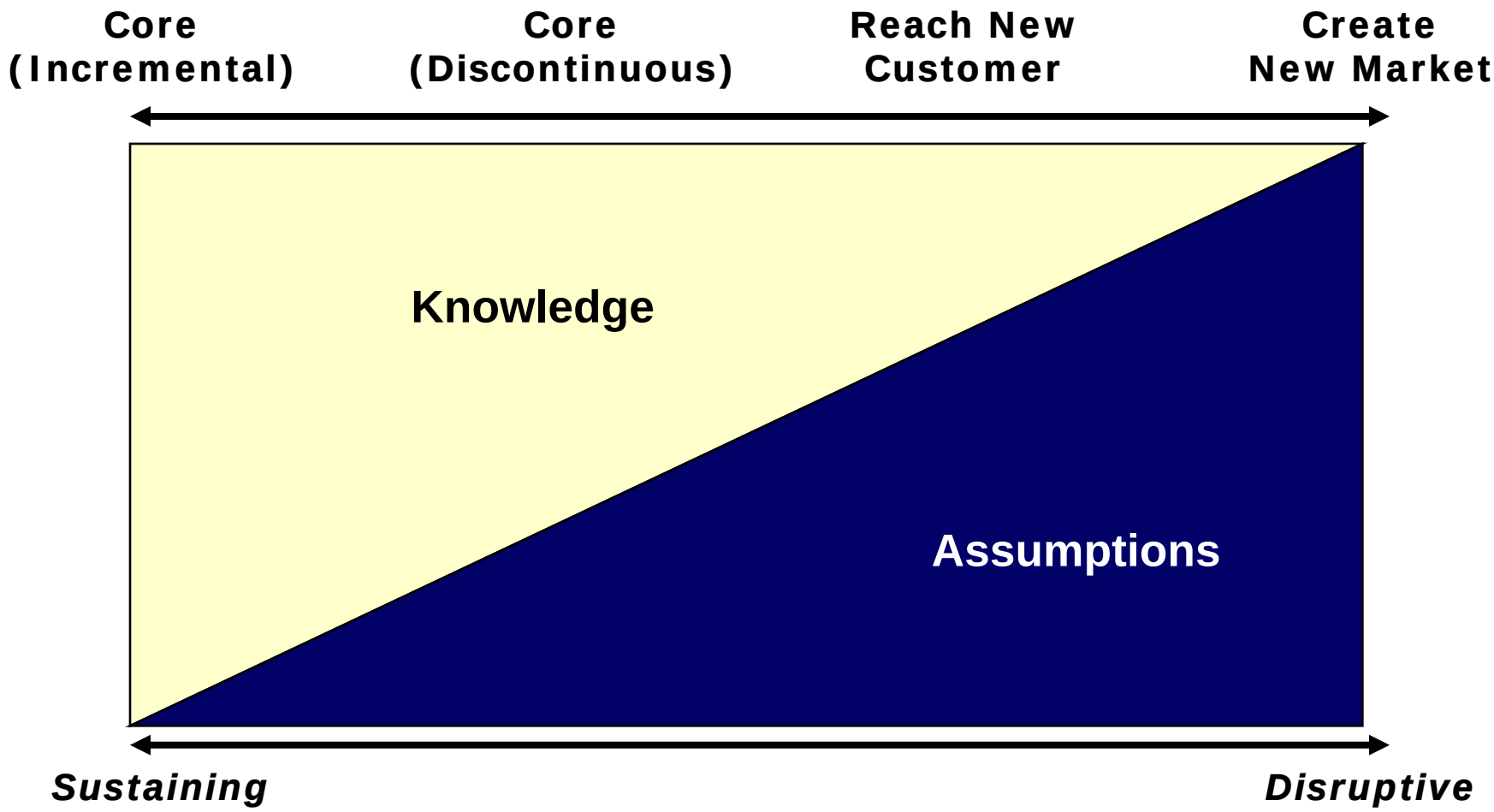
Remember: Quality is relative

Success in Any Uncertain Environment Requires Testing, Experimenting & Adapting



More than 90% of successful new ventures start off following the wrong strategy

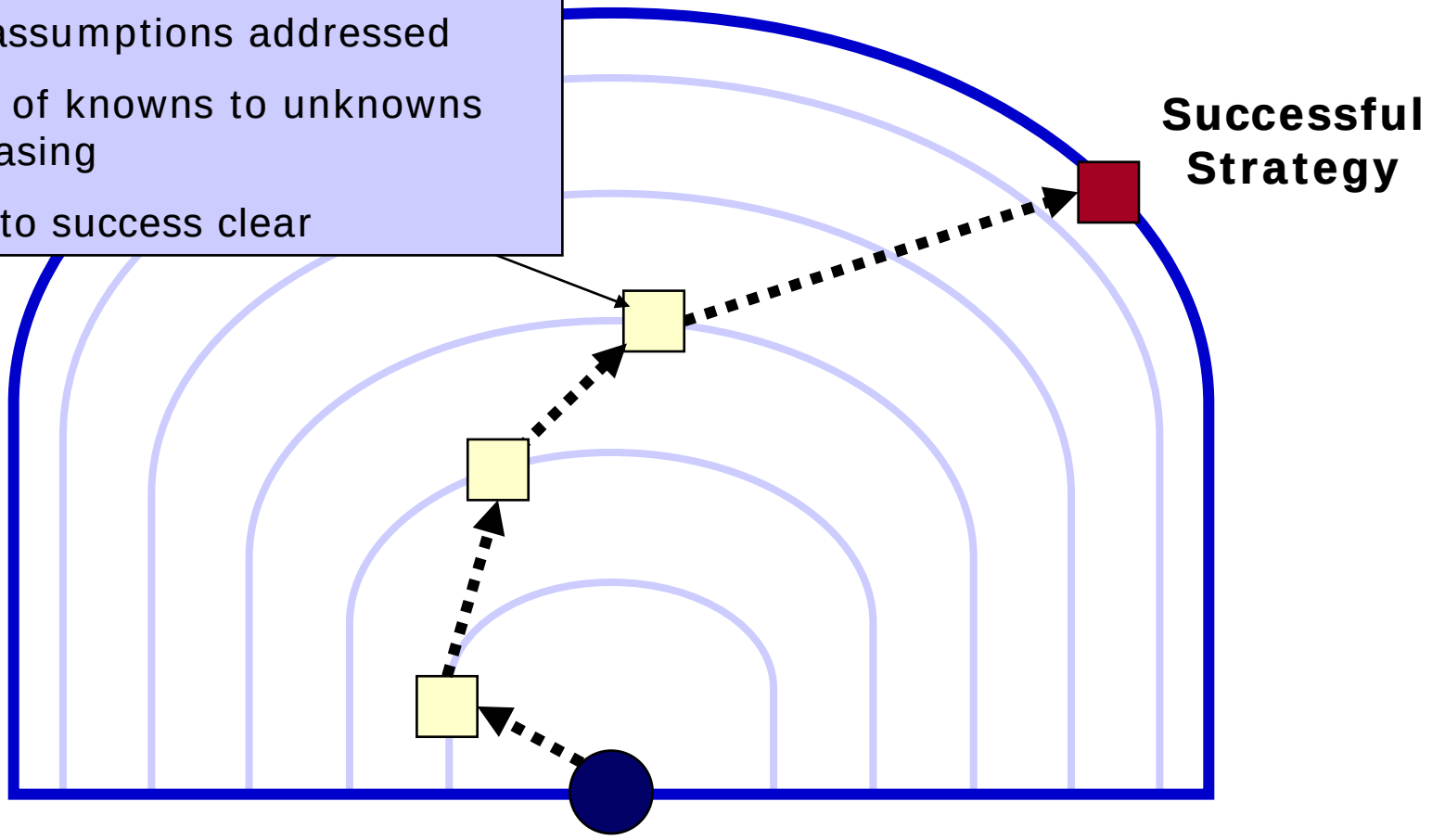
Understanding the Knowledge to Assumption Ratio



Continue Adapting Until Signs Are Clear

Point Where Signs are Clear

- Successful business model
- Key assumptions addressed
- Ratio of knowns to unknowns increasing
- Path to success clear



Summary

1) Have a common language about Innovation

2) Match the Innovation with the right Processes and Values

3) Focus on the “job” to be done

4) Utilize a planning process focused on learning

5) Precision around assumptions, not metrics

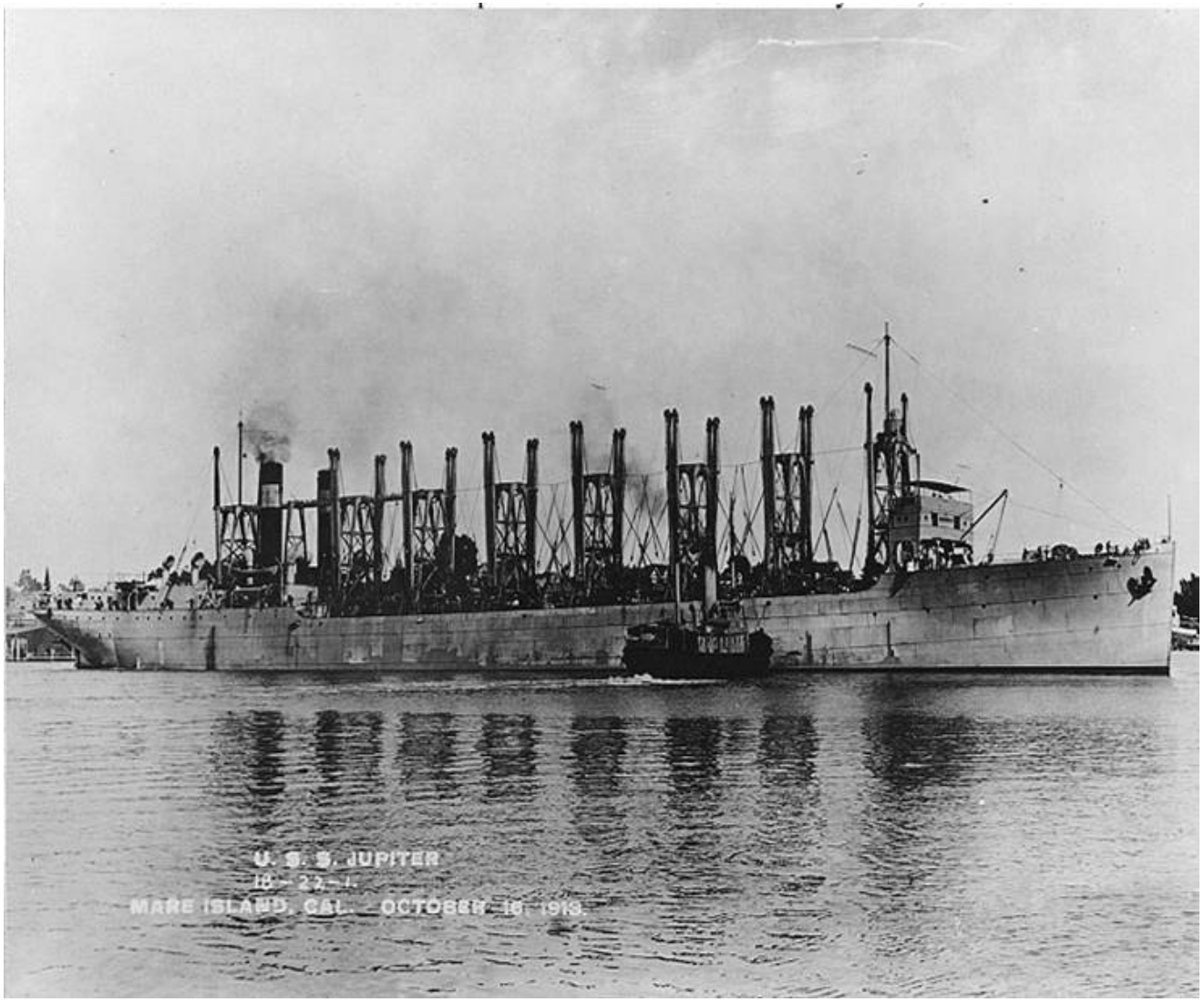
Advanced Capability Electric Systems

NDIA Disruptive Technologies Conference,
September 2006

Scott Littlefield
Office of Naval Research

USS Jupiter- 1913

Early example of Electric Drive



Navy is going electric

- T-AKE (Cargo Ship) – Diesel-electric system, with in-hull electric motors.
  - Enabled improved internal arrangements, with room for more cargo.
- LHD-8 (Amphibious Ship) – Hybrid system, with diesel-electric low speed mode and gas turbine mechanical drive at higher speeds.
  - Enables very efficient low-speed cruise.
- DD(X) Destroyer
  - First attempt at a power-dense, modern, militarized electric drive system.

Why is the Navy Going Electric?

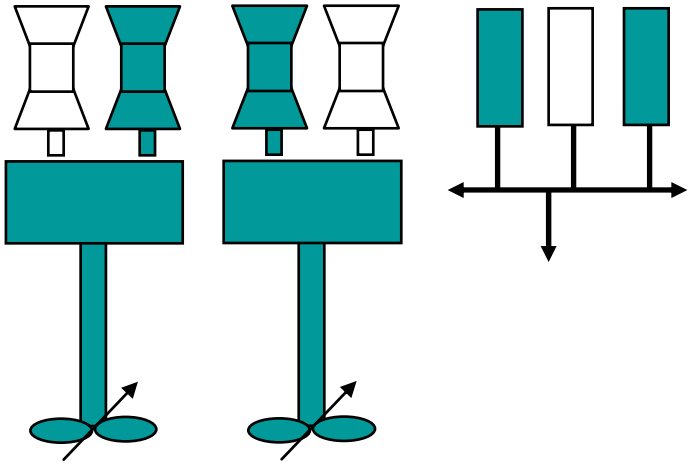
- Enable Transformational Weapons Systems
  - Electromagnetic Guns
  - Shipboard Laser Systems
  - Advanced Sensors

- Improve Survivability
  - Rapid and anticipatory Reconfiguration of Power and systems
- Reduce Signatures
  - Eliminates propulsion gear noise
  - Enables lower speed propellers
  - Enables silent watch capabilities

- Reduce Life Cycle Costs
  - Reduction in Number of Prime Movers
  - Significantly Greater Fuel Efficiency
  - Eliminate high maintenance hydraulic systems

Integrated Power System leads to Reduced Number of Prime Movers

Mechanical Drive

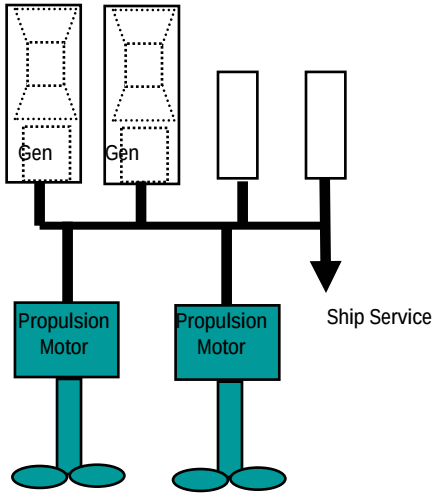


Current DDG-51 class has seven gas turbines

Life Cycle Cost Drivers:

- Initial Acquisition Cost
- Manning
- Maintenance
- Fuel Consumption

IPS



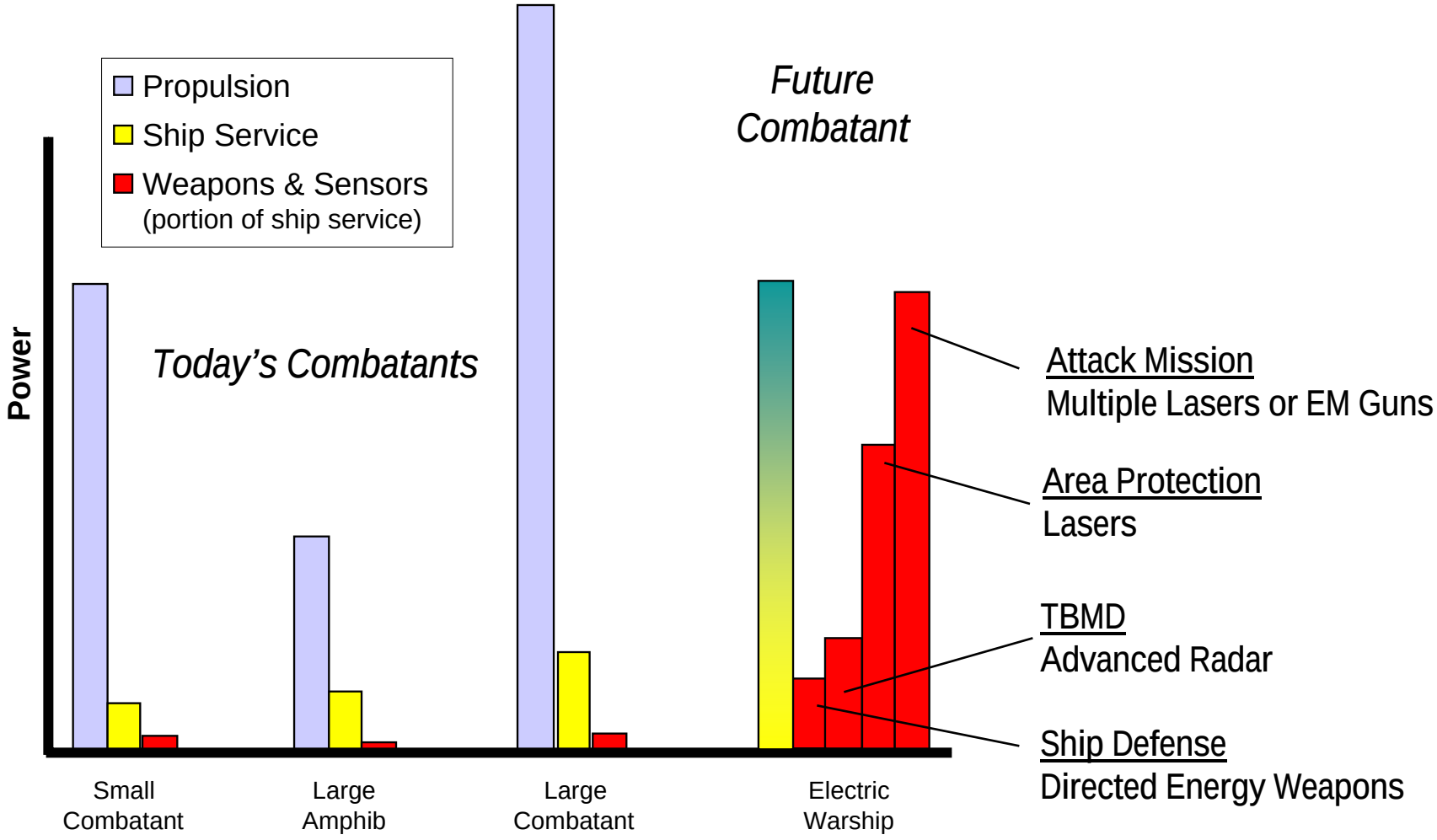
DD(X) will have four gas turbines

Thus lower Life Cycle Costs!

Is it Disruptive?

- Potentially - - -
  - Order of Magnitude increase in available power for non-propulsion electrical loads
    - Directed Energy Weapons
    - Electromagnetic Launchers and EM Guns
    - Advanced Sensors
    - Others?

Expected Growth in Power Requirements



Directed Energy

Why is it Important?

- Speed of light delivery for wide range of missions and threats
- Precise aim point and delivery with controlled effects and minimal collateral damage
  - Hard Kill or Soft Kill
- All electric for deep magazine without danger and logistics of conventional ordnance
- Rapid Retargeting

What is it?

Laser Type Tailored to Application

Free Electron Laser Weapon System

- Scalable to high power for ship defense
- Tunable wavelength for maritime environment

Electric Fiber Laser weapon system

- *Light weight Laser system based upon fiber lasers for tactical aircraft*

Who Needs it?

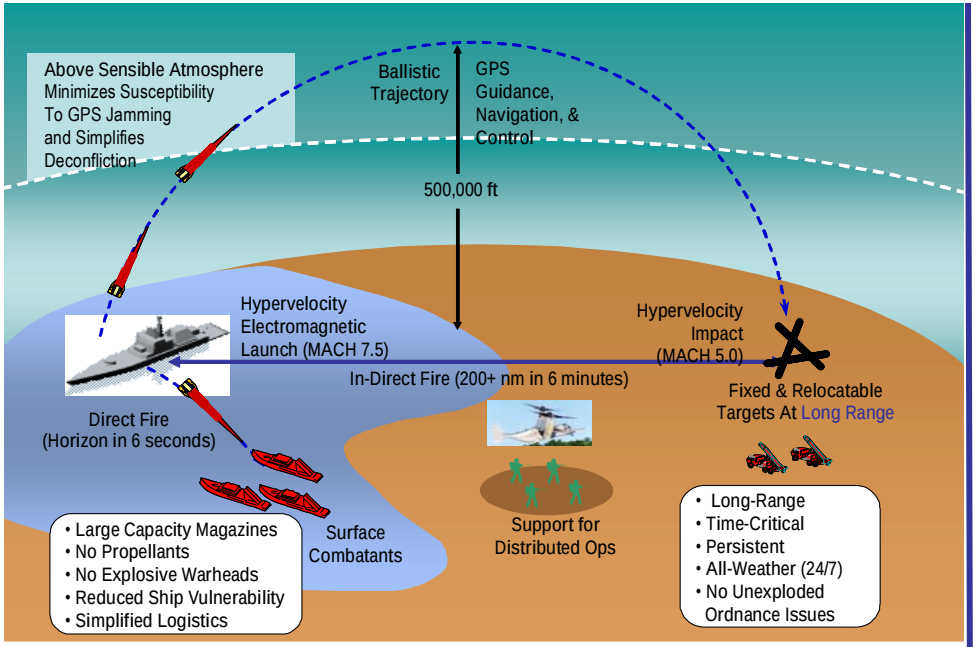
Surface Navy

- Ship self defense against cruise missiles and swarming small targets
- Theater Ballistic Missile Defense

Navy Aviation

- Accurate long range (>20km) land target engagement
- Anti air engagement (offensive & defensive)

Electromagnetic Railgun



What is it?

- Gun fired with electricity rather than gunpowder
- > ***200 mile range in 6 minutes***
- Highly accurate, lethal guided projectile (GPS)
- Minimum collateral damage

Why is it important?

- Volume & Precision Fires
- Time Critical Strike

- All weather availability
- Variety of payload packages
- Deep Magazines
- Non explosive round/No gun propellant
  - Greatly simplified logistics
  - No IM (Insensitive Munitions) Issues
- Scalable effects
- Missile ranges at bullet prices

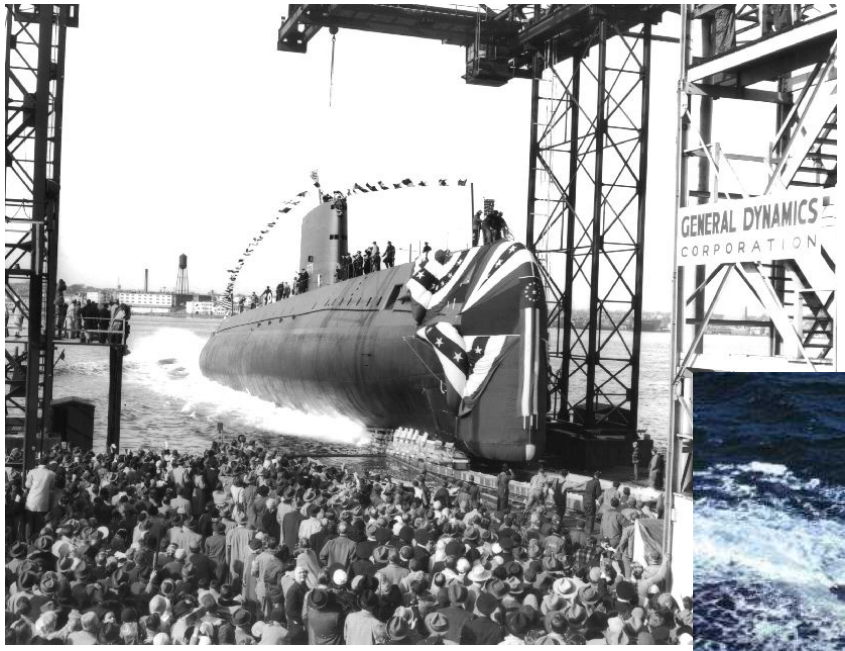
Who needs it?

- Marines and Army troops on ground
- Special forces clandestine ops
- GWOT
- Suppress air defenses

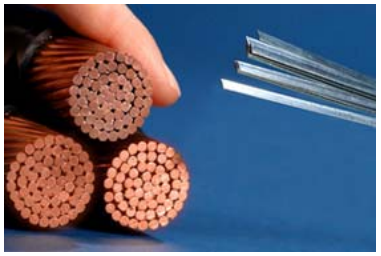
When?

- Feasibility Demo 2011
- System Demo 2015
- IOC 2020-2025

A New Propulsion System can be the Trigger for a Disruptive Capability



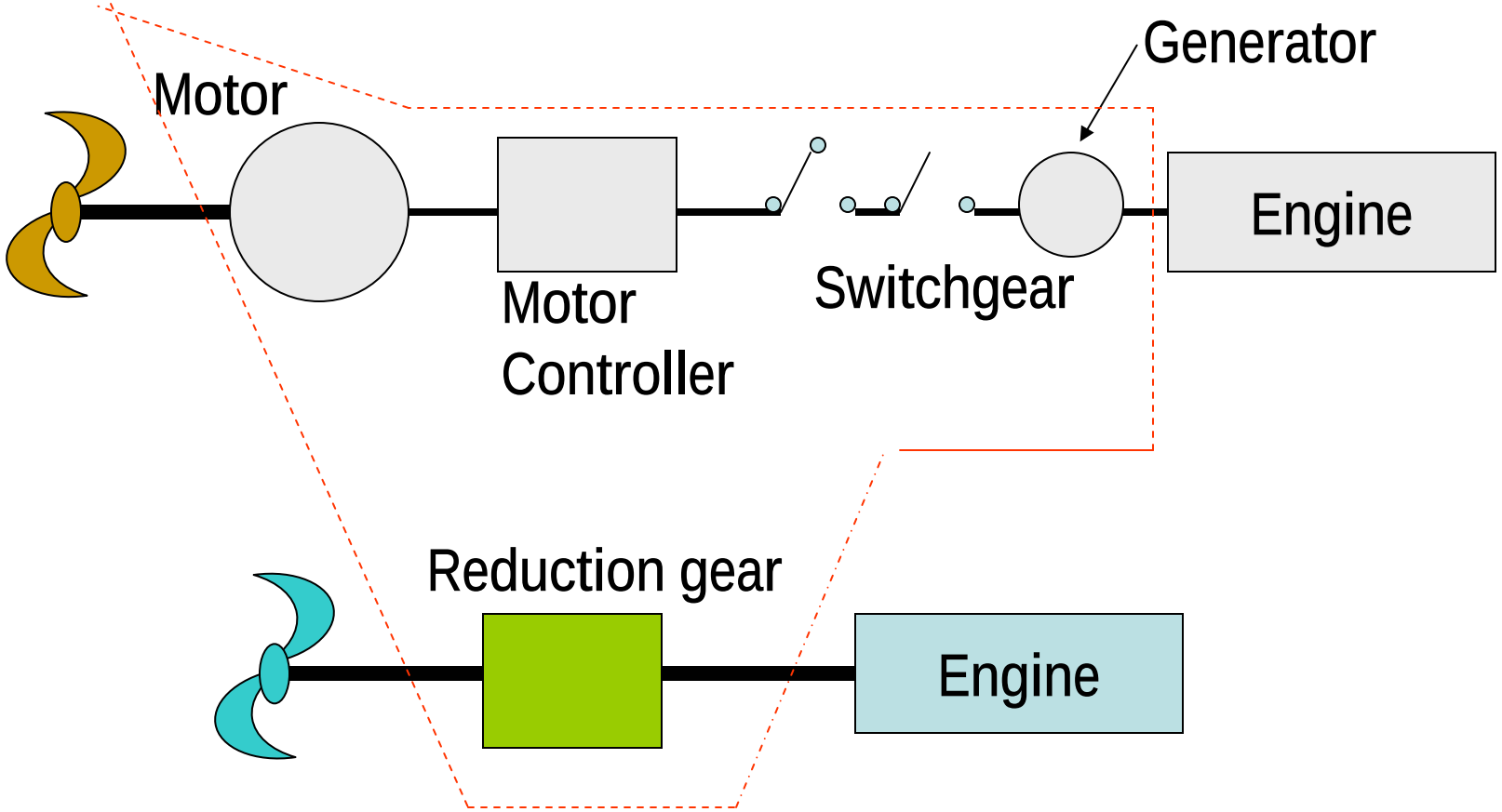
Dual Use Technology?



Key Issues for Navy

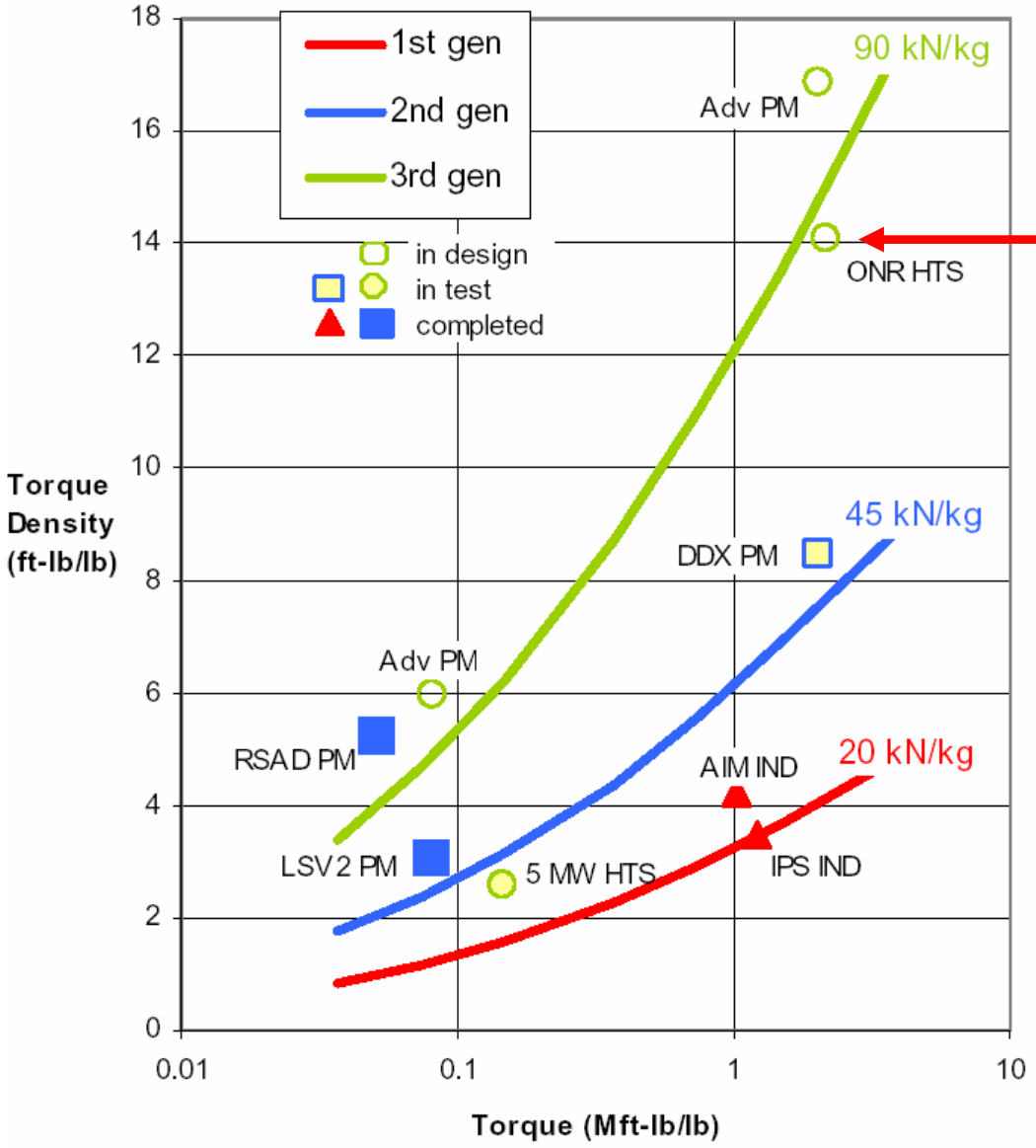
- Power Density
  - Components
  - Distribution Architecture
- Fuel Efficiency
- Pulsed Power
- Signatures

Power Density Issue



Mechanical Drive still beats Electric Drive on Power Density.

Motor Torque Density



To be demonstrated at full scale in 2007.

Figure courtesy of Peter Mongeau, ASNE Electric Machines Technology Symposium, Philadelphia PA, January 2004

NRAC Summer Study – Future Fuels

- National Petroleum Usage – 16M BPD
- DOD Usage – 300K BPD (about 2% of national usage).
- DOD Usage:
    - Aircraft 73%
    - Ground 15%
    - Ships 8%
    - Installations 4%
- Recommendation – DOD catalyze manufactured hydrocarbon liquid fuels infrastructure through long term purchase contracts.

Future S&T Directions:

- High Speed / High Frequency Generators
- Advanced Distribution Architecture
- Innovative Ship Propulsion
- Compact Power Electronics and Energy Storage to Support Pulsed Power Weapons and Sensors.

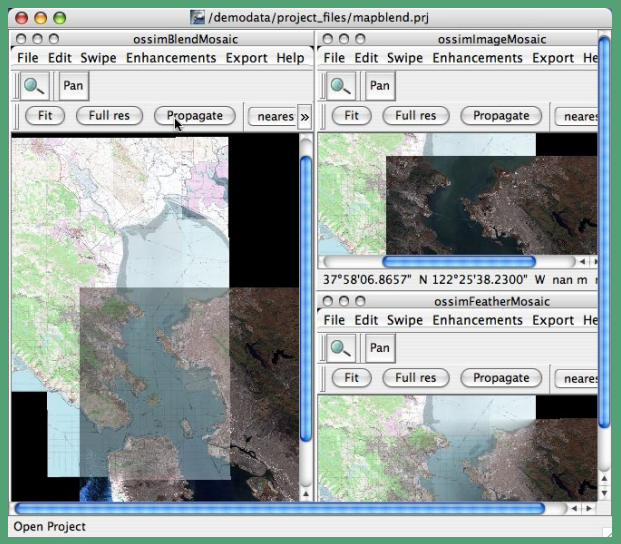
Relevant Research and Results . . .Yesterday, Today, and Tomorrow

Questions?

OSSIM Overview

Mark Lucas
OSSIM

RadiantBlue TECHNOLOGIES



OSGeo.org
The Open Source Geospatial Foundation

"Awesome"

Open Source Software Image Map (OSSIM)

www.ossim.org

OSSIM

High Performance Geo-spatial Image Processing

Open Source Software Distribution

Laptops to Clusters - Mac OSX, Linux, Windows, Solaris

Sensor Models, RPC, Commercial and National Formats

Precision Terrain Correction / Orthos

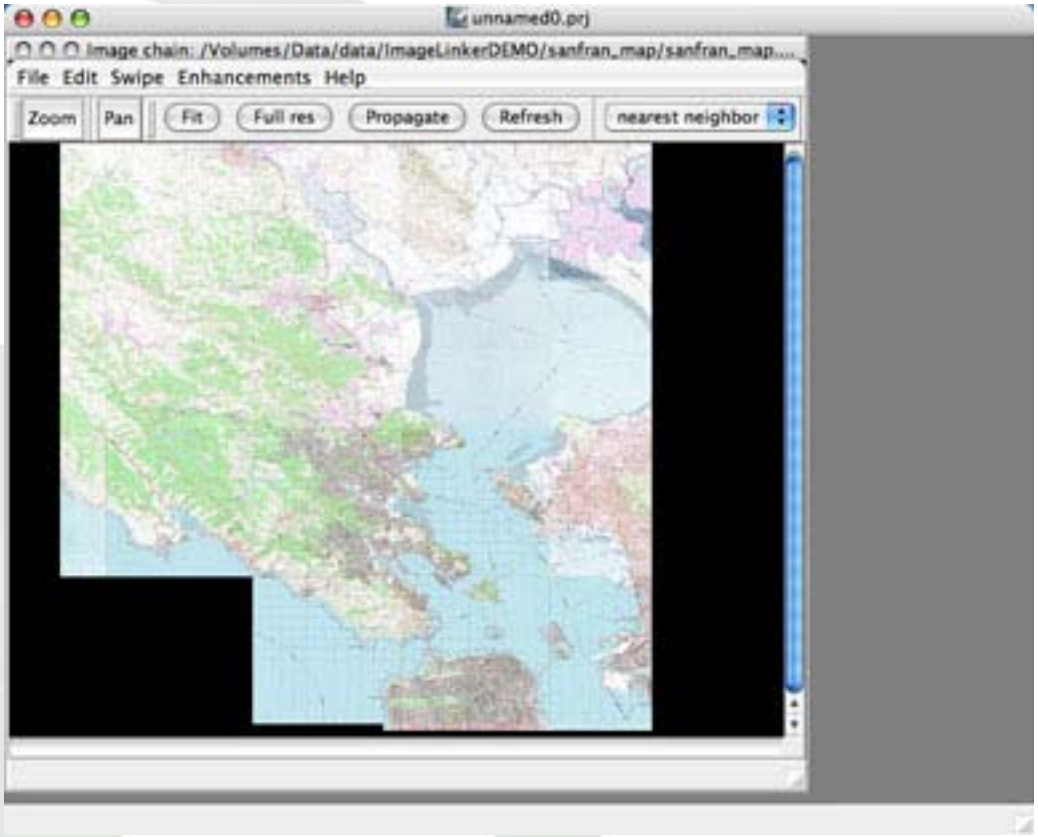
Production, Prototyping, Advanced Visualization

Used in Government and Commercial Applications

OGC Interfaces over the web

OSSIM

1.7 GB Raster GeoTiff of San Francisco

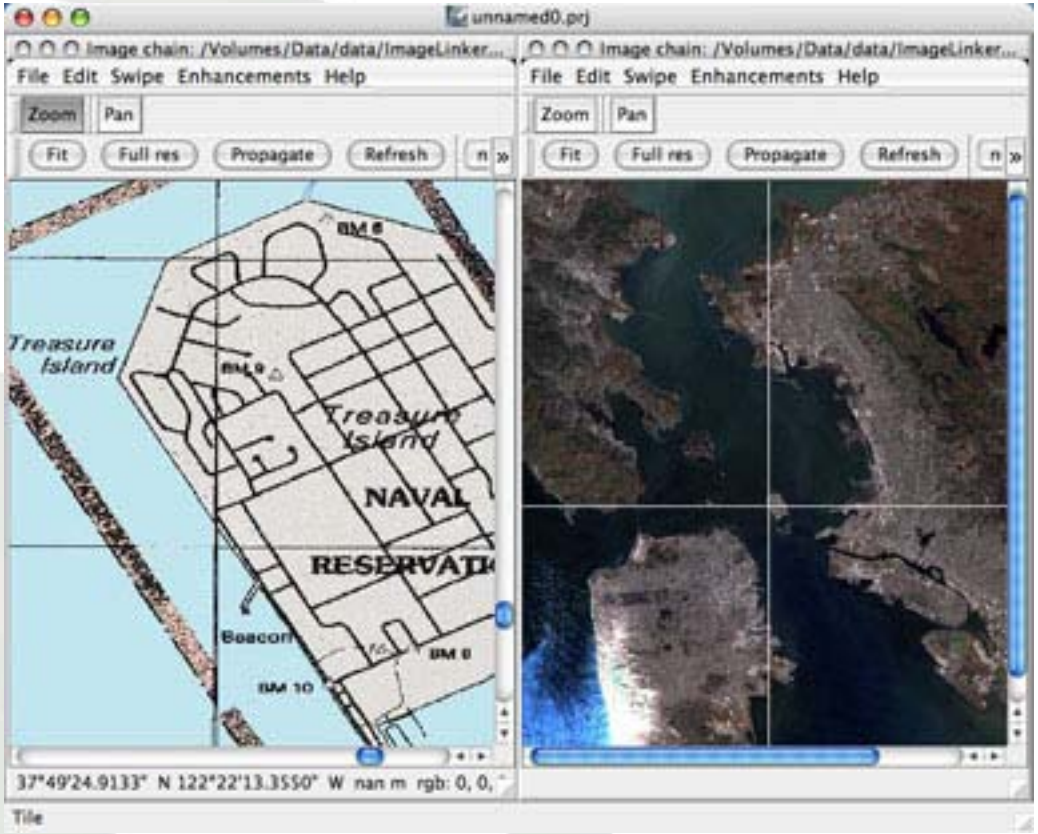


OSSIM

Arbitrary Panning and Zooming

OSSIM

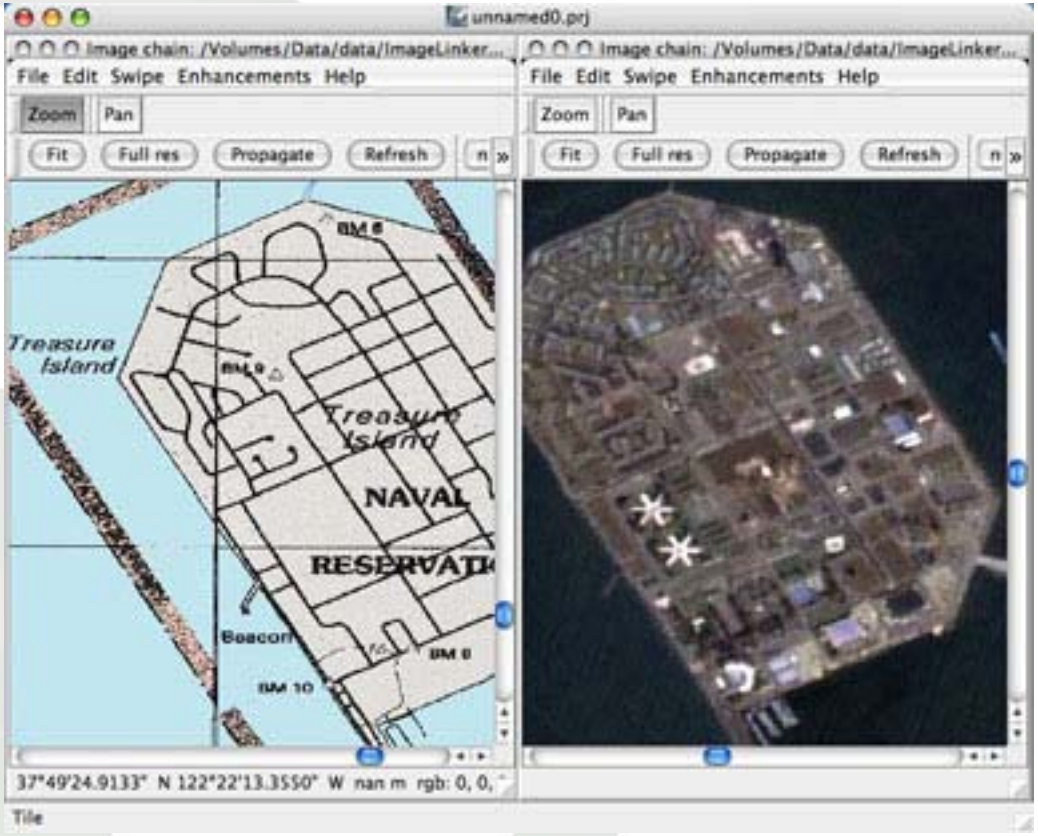
263 MB Landsat image



Different Scale, Format, Mapping Projections

OSSIM

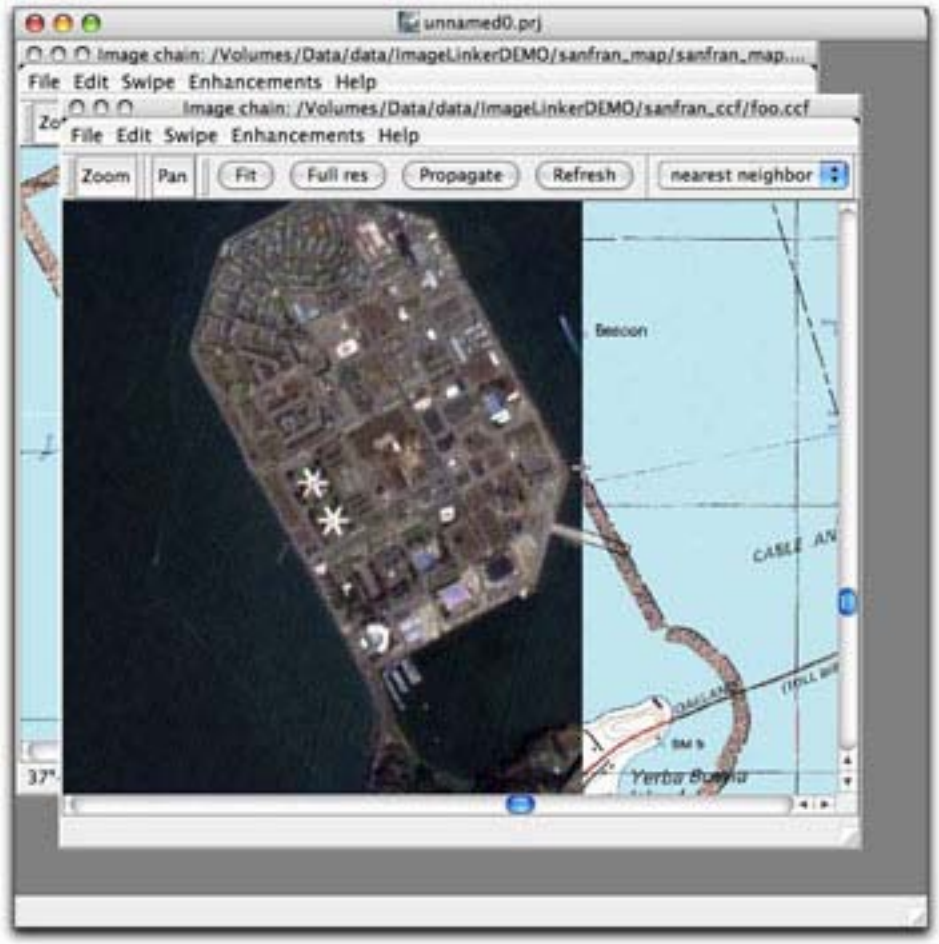
Publish Viewing Geometries



All Windows Display Same View

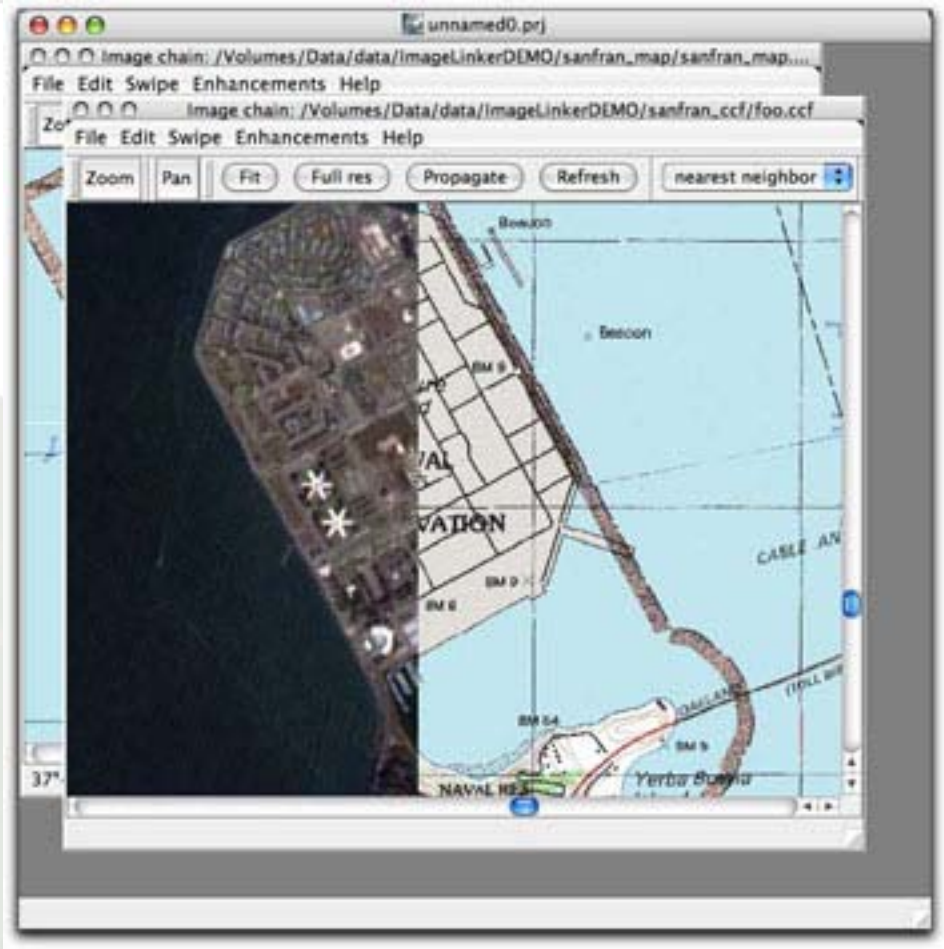
OSSIM

Swipe Displays



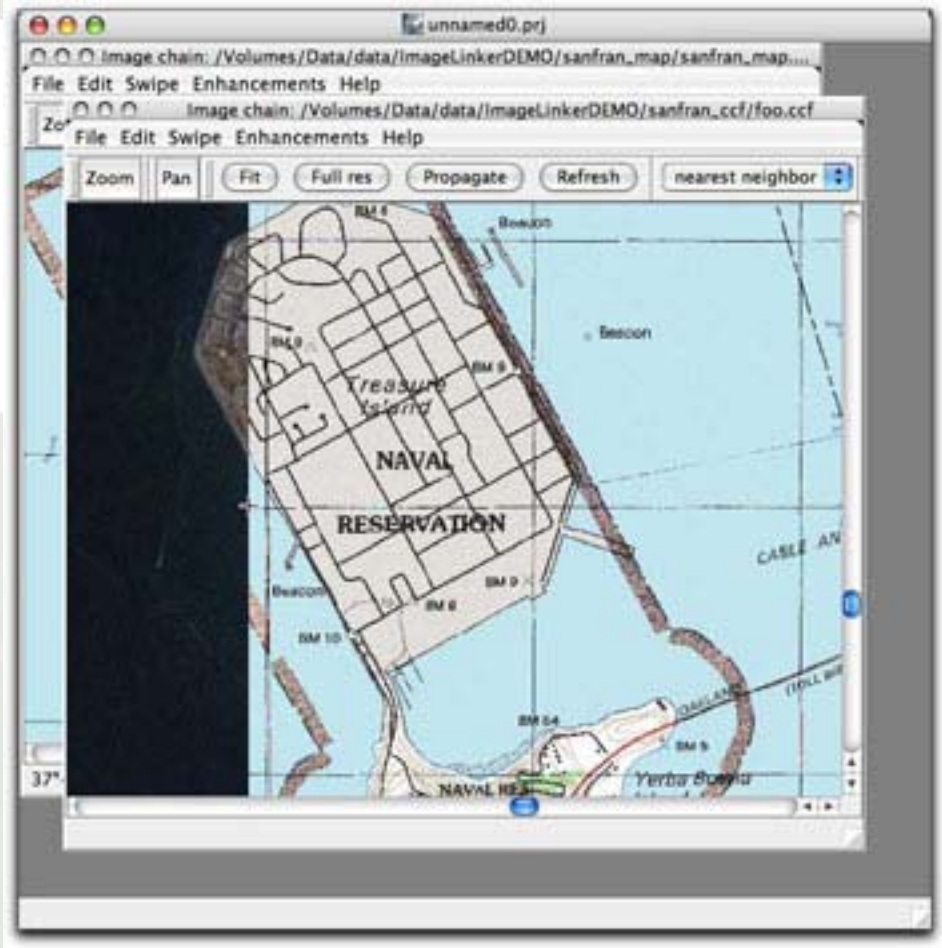
OSSIM

Swipe Displays



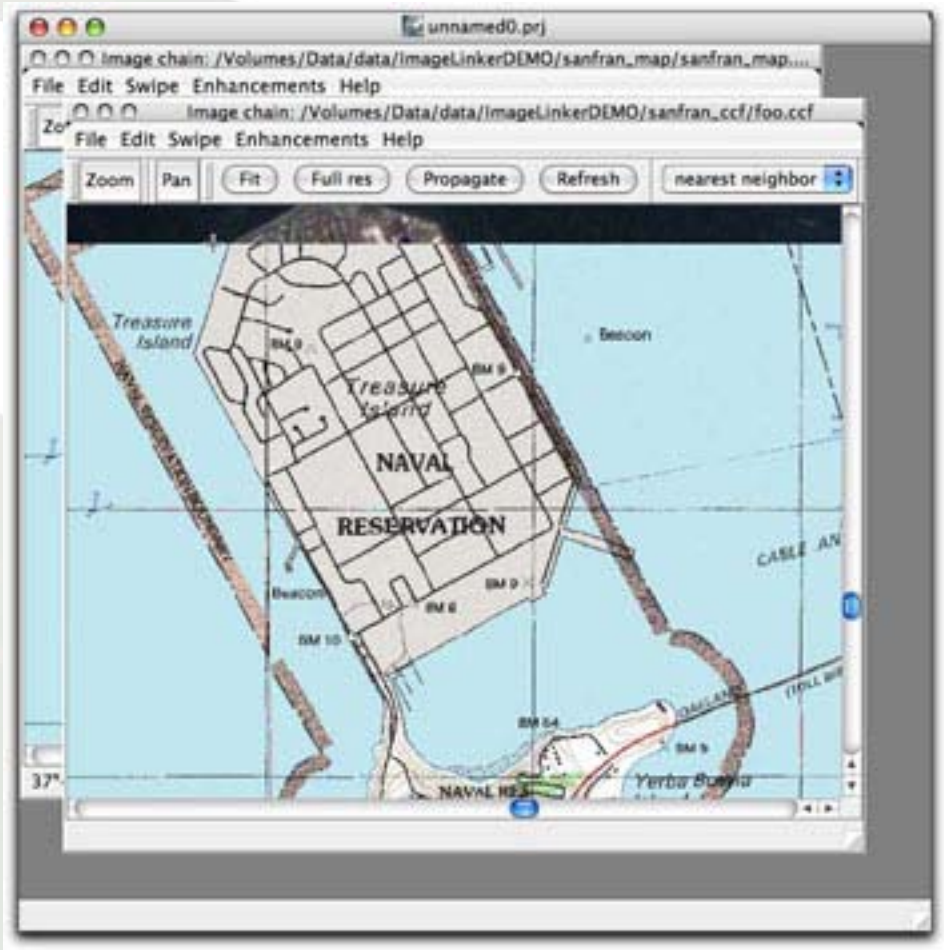
OSSIM

Swipe Displays



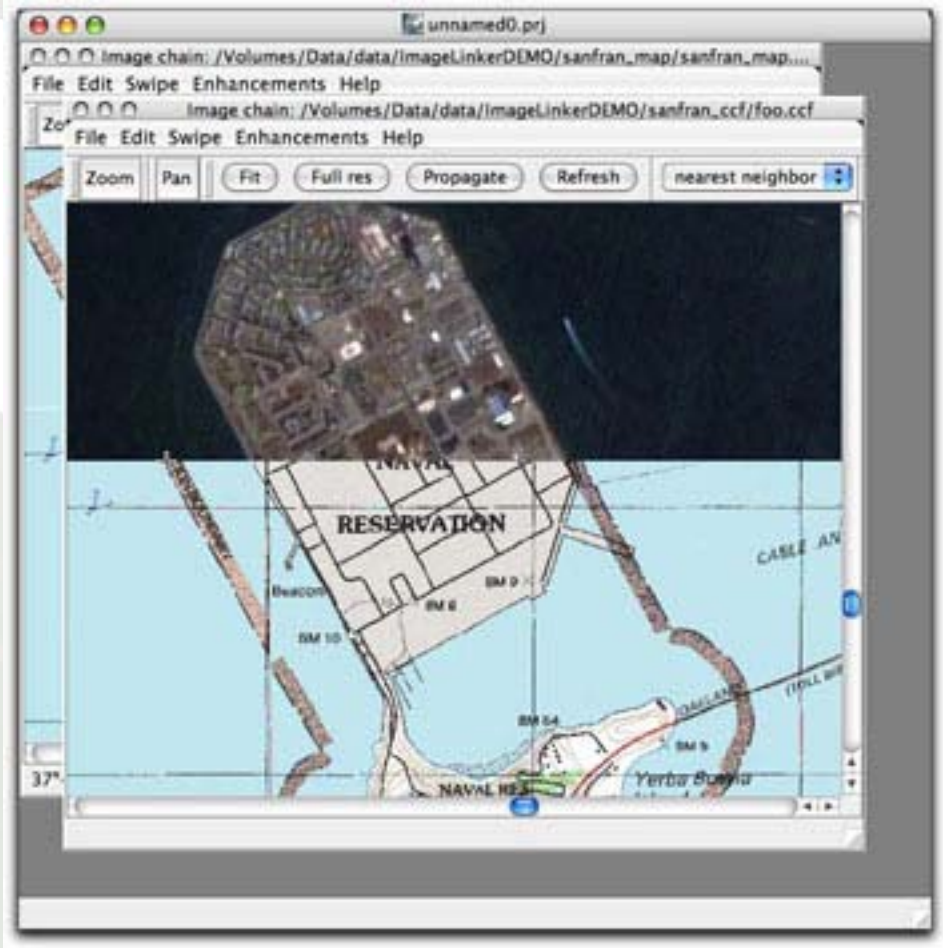
OSSIM

Swipe Displays



OSSIM

Swipe Displays

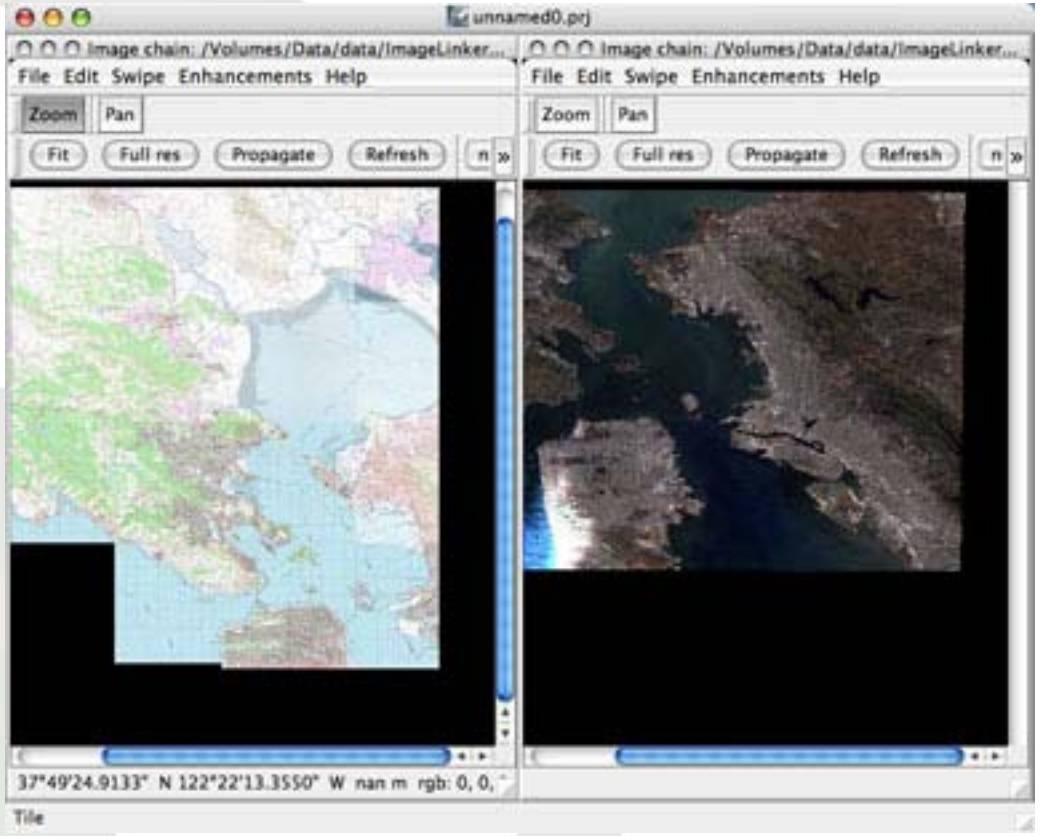


OSSIM

Swipe Displays

OSSIM

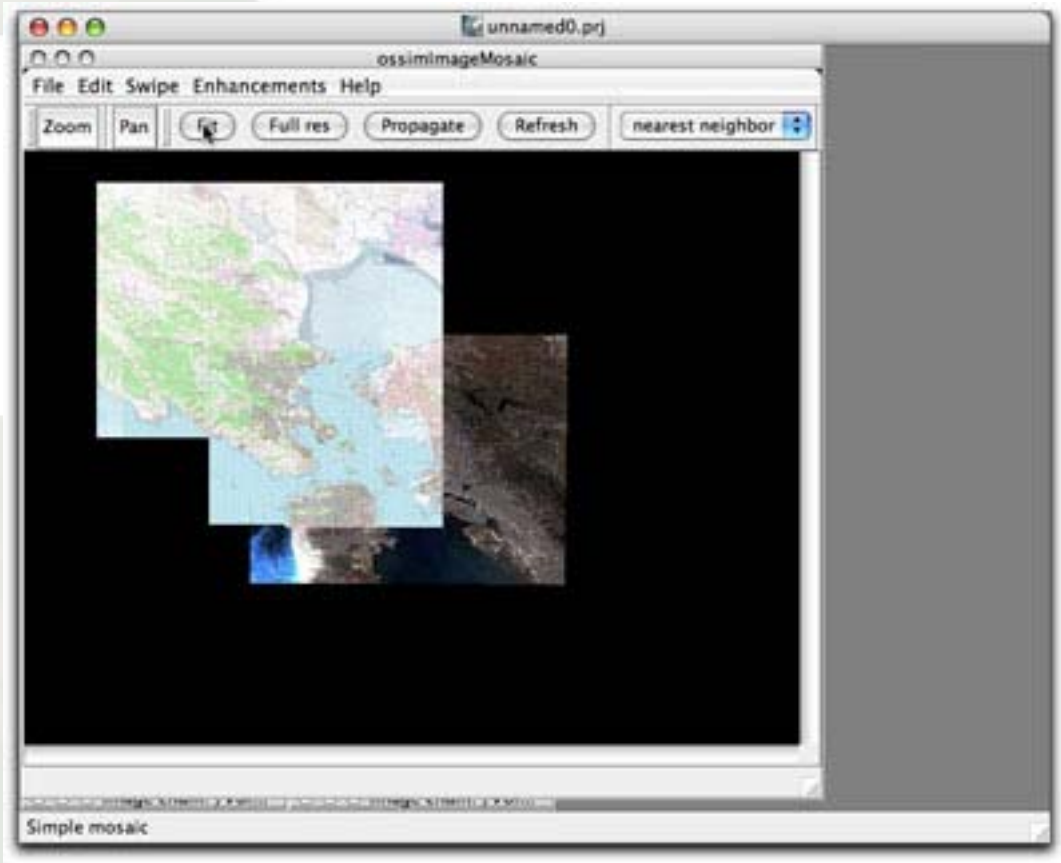
Fit to Window



Quick Overviews

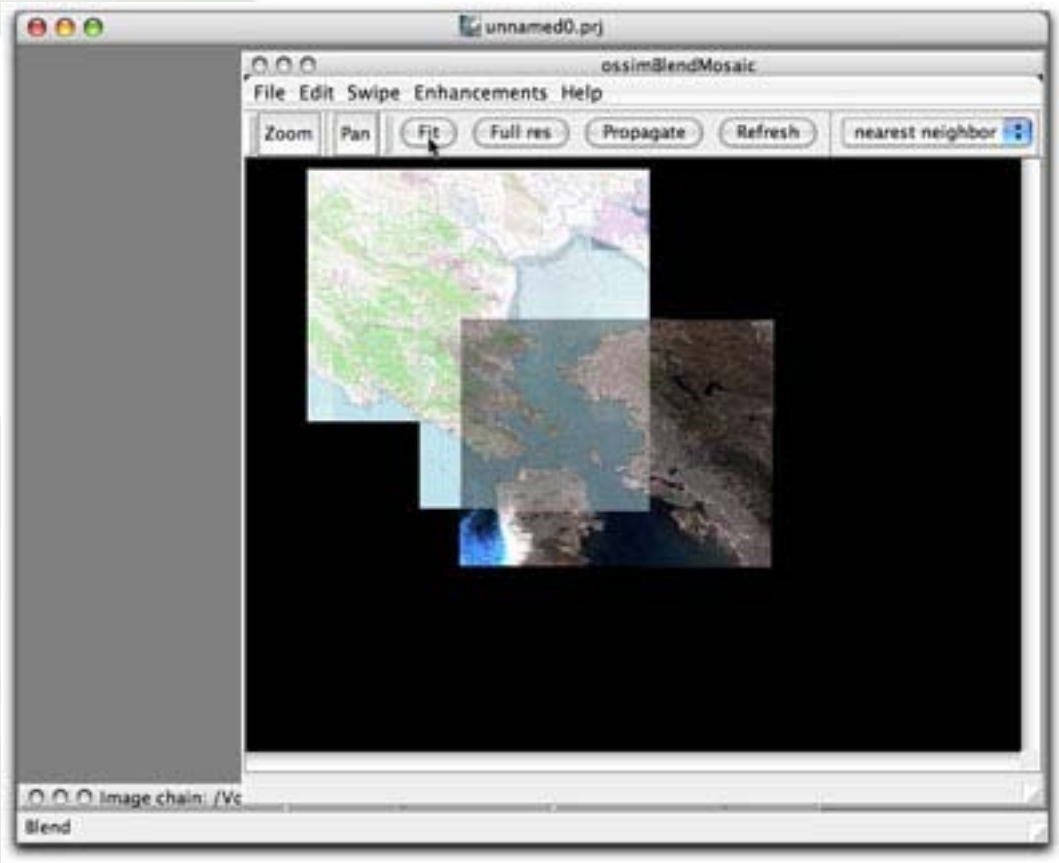
OSSIM

Mosaics



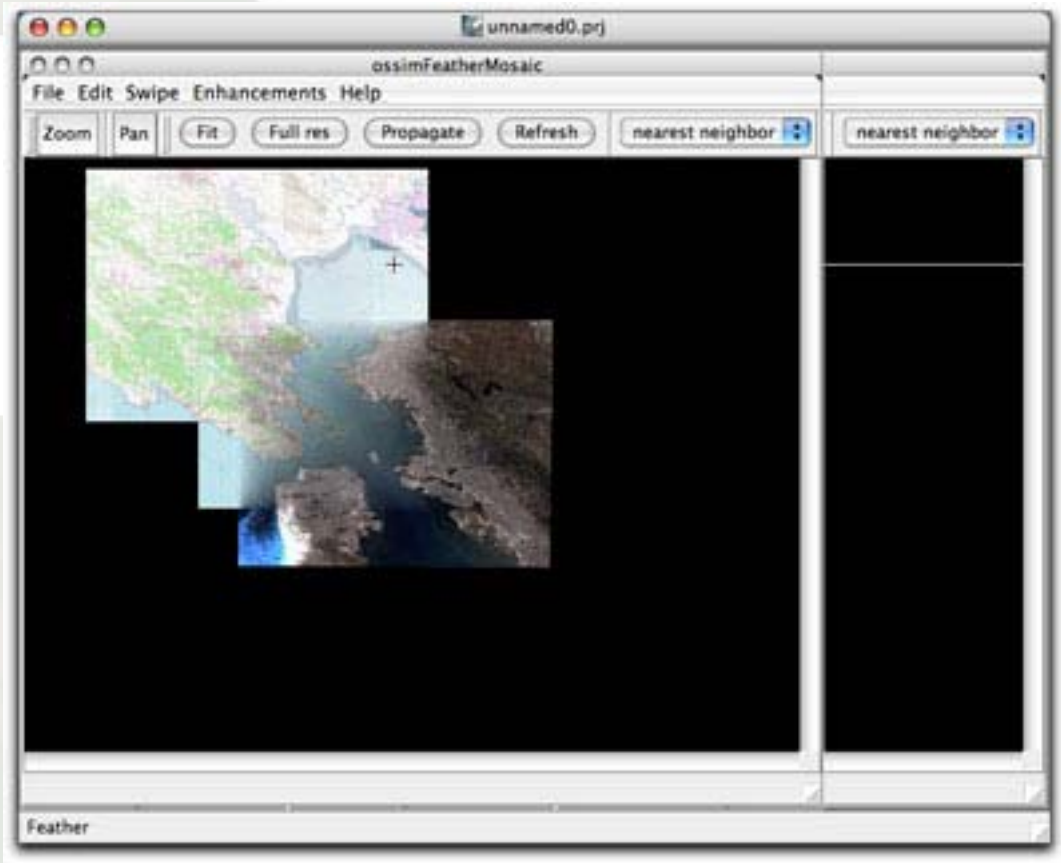
OSSIM

Blends



OSSIM

Feathering



OSSIM

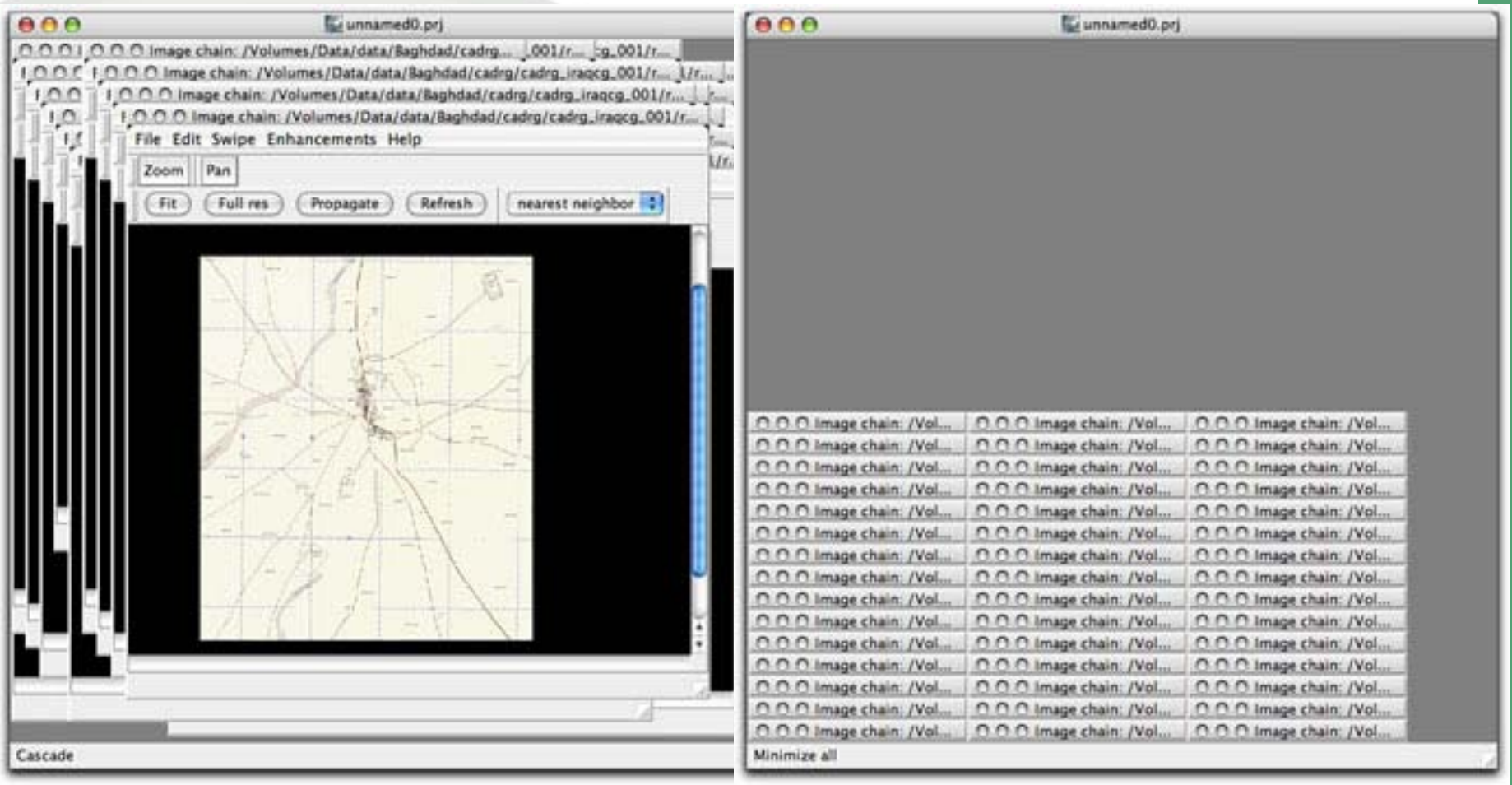
Elevation Processing

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (Uncompressed) decompress
are needed to see this picture.

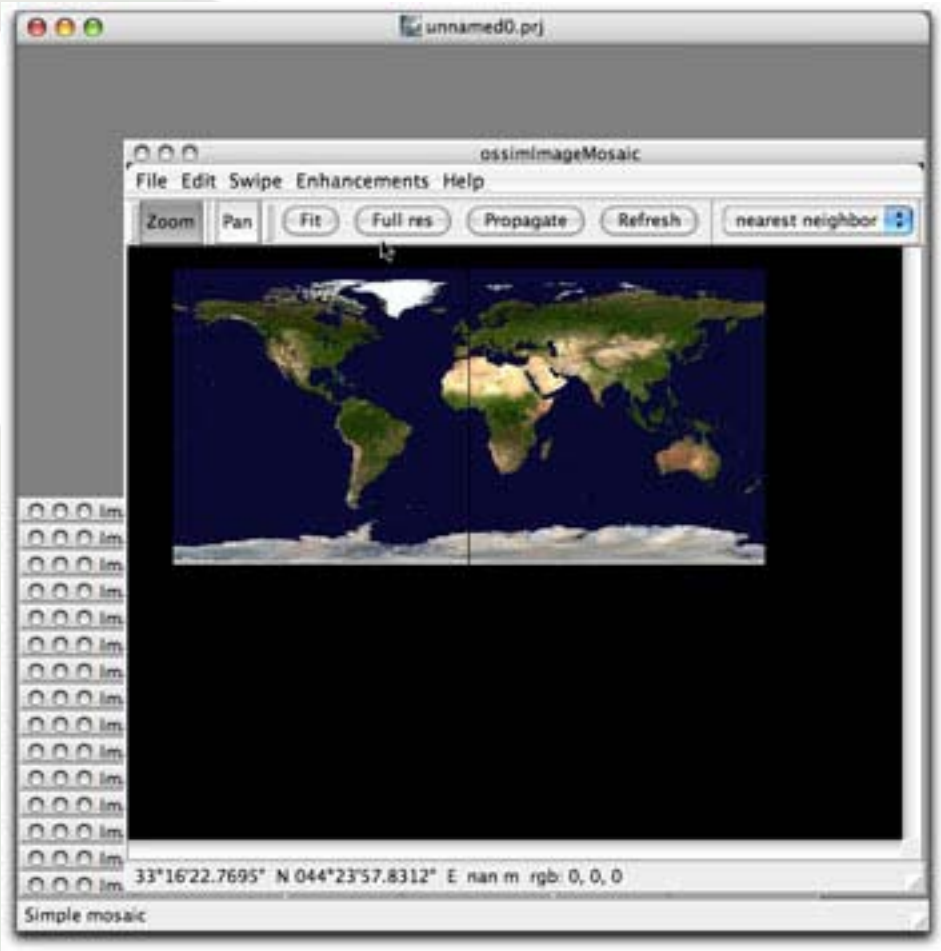
OSSIM

CADRG, SPOT, QB, CIB, NASA Data



OSSIM

Very Large Mosaics



OSSIM

On a Laptop

OSSIM

NASA 2.6 Gig File

OSSIM

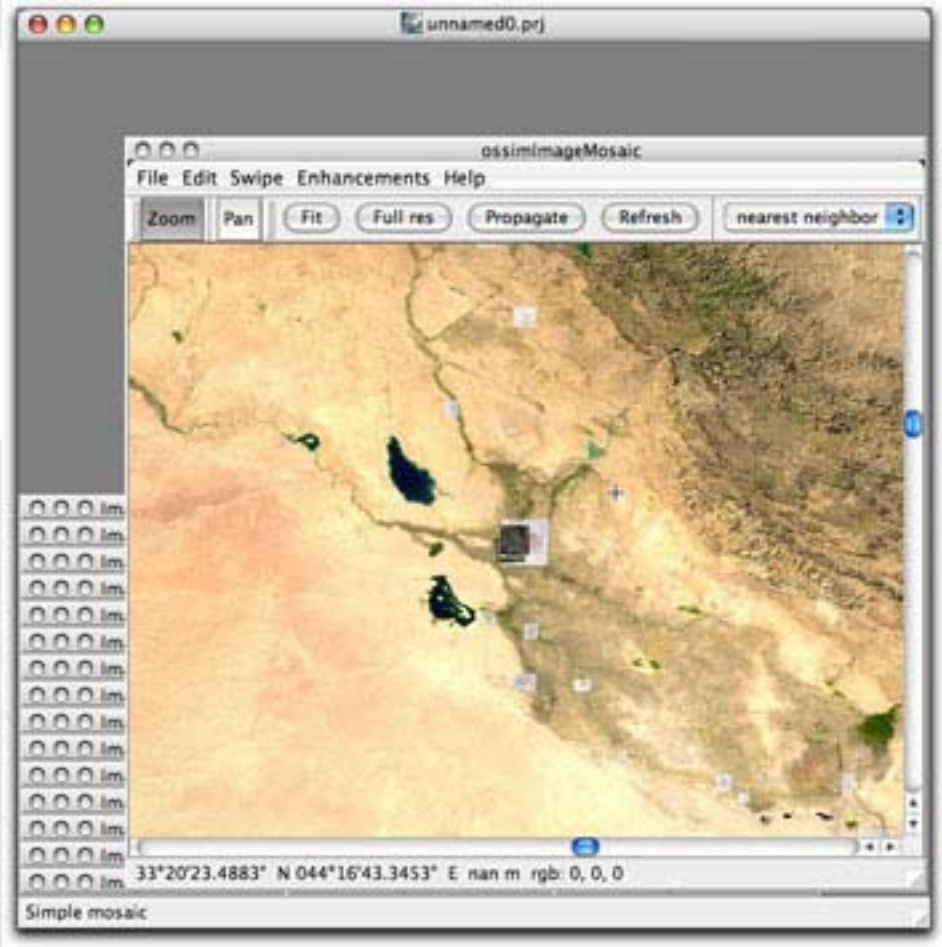
Zoom to Baghdad

OSSIM

Middle East

OSSIM

CADRG Maps through a.toc

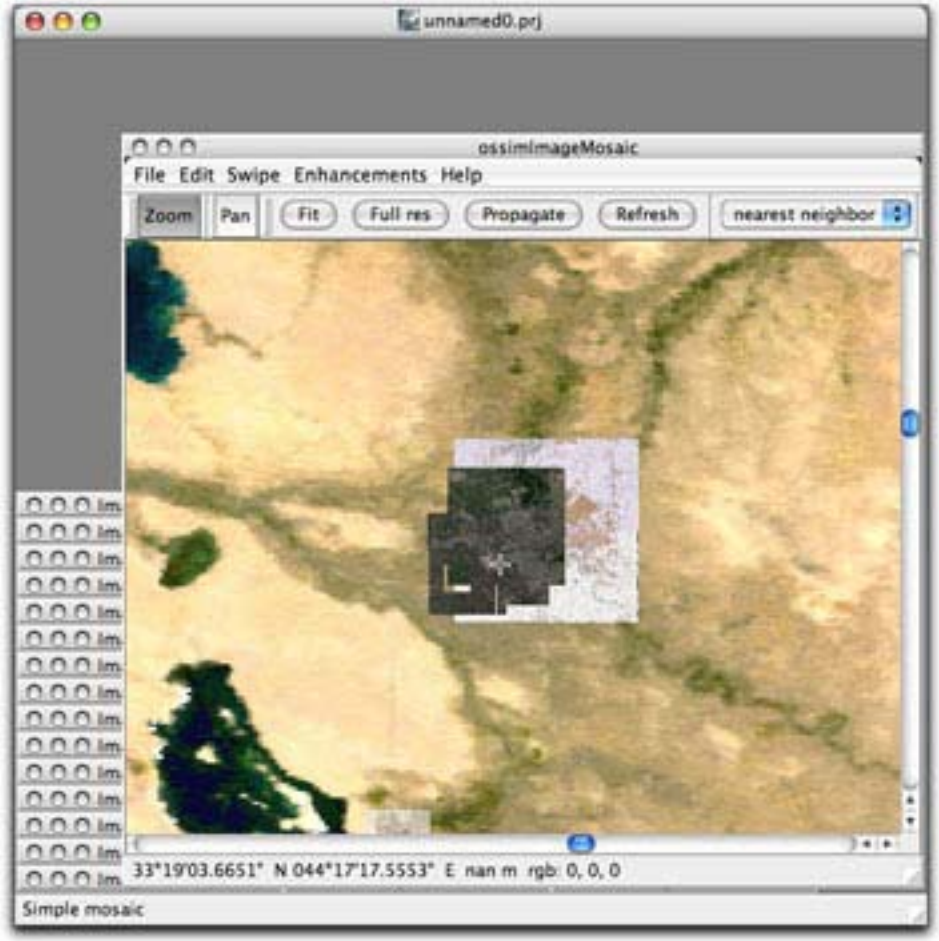


OSSIM

SPOT 5 Image

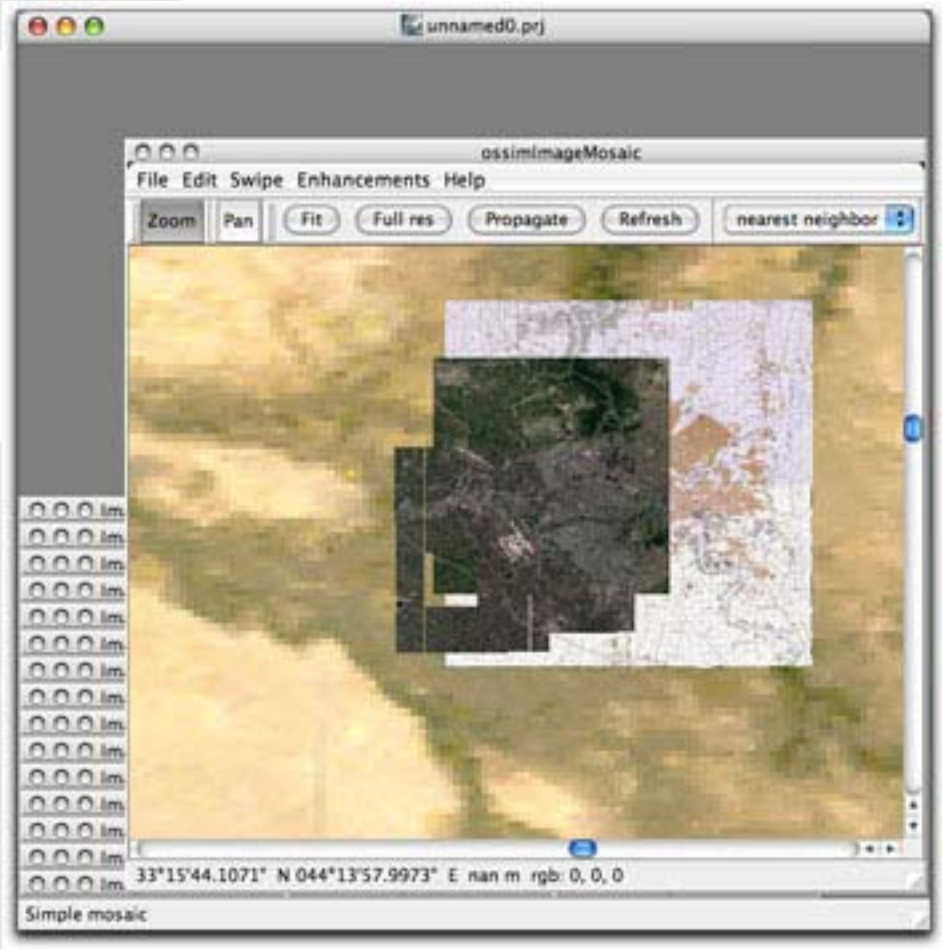
OSSIM

Digital Globe QuickBird Mosaic



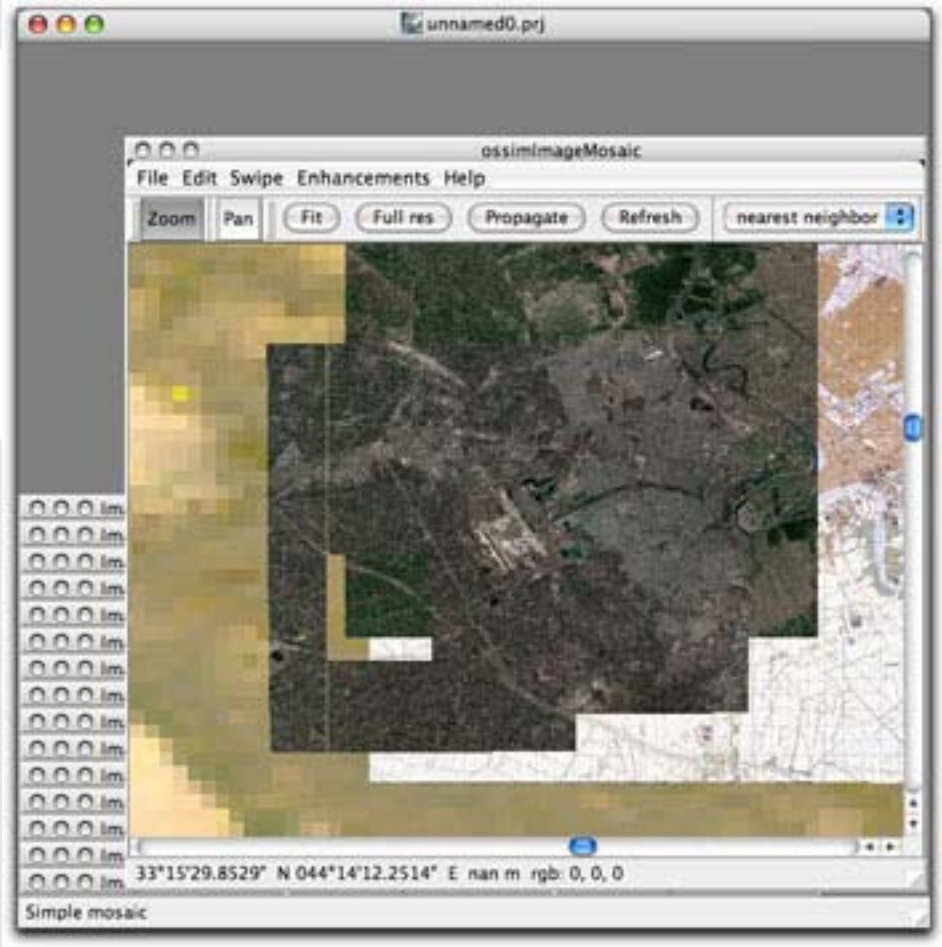
OSSIM

Baghdad Area



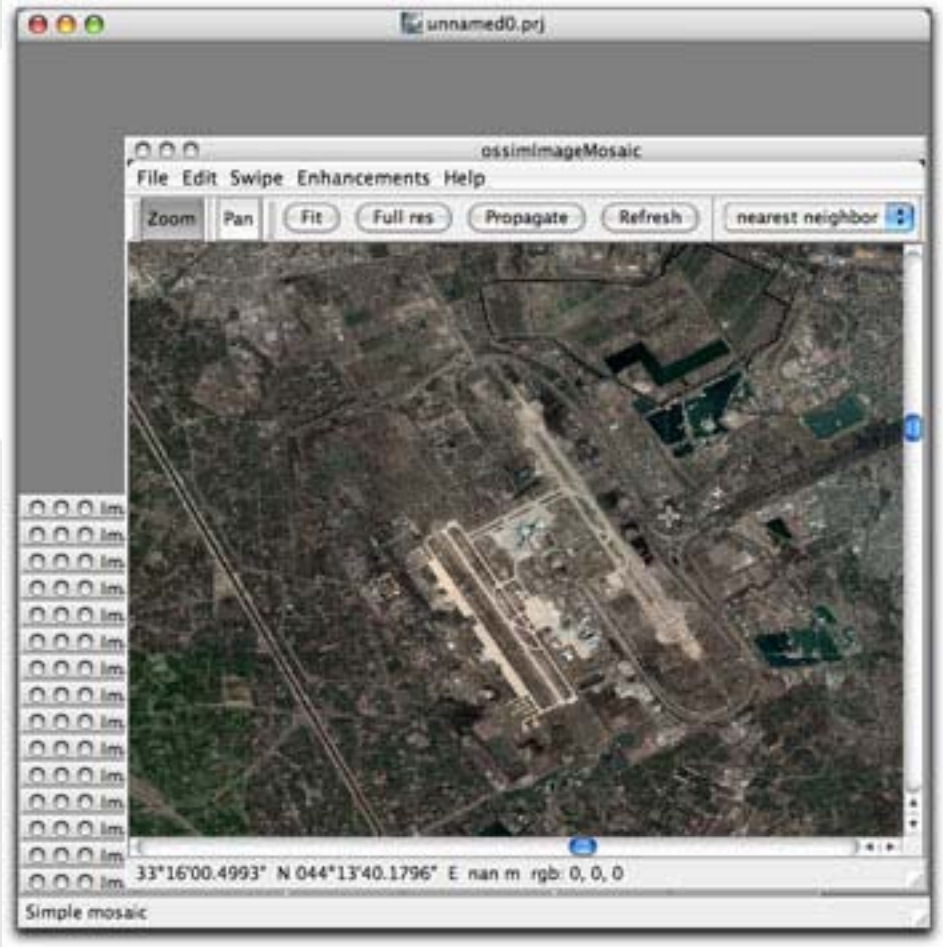
OSSIM

Zoom to Airport



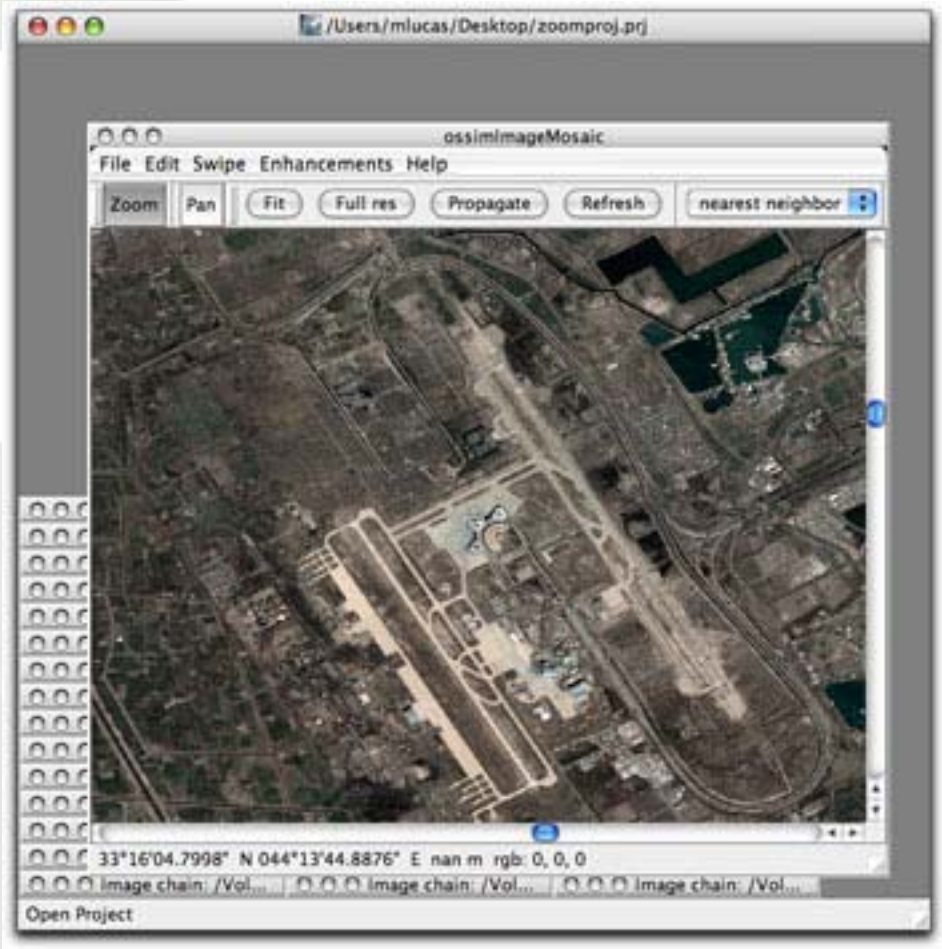
OSSIM

Baghdad Airport



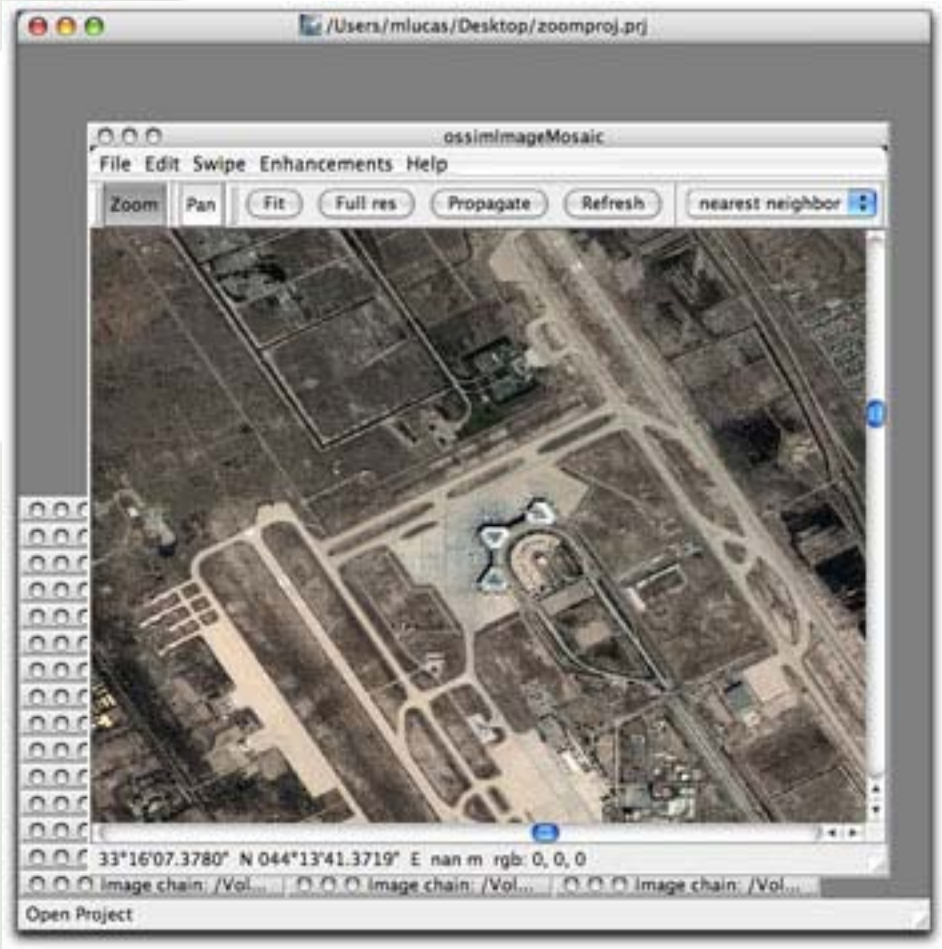
OSSIM

30 GB Mosaic



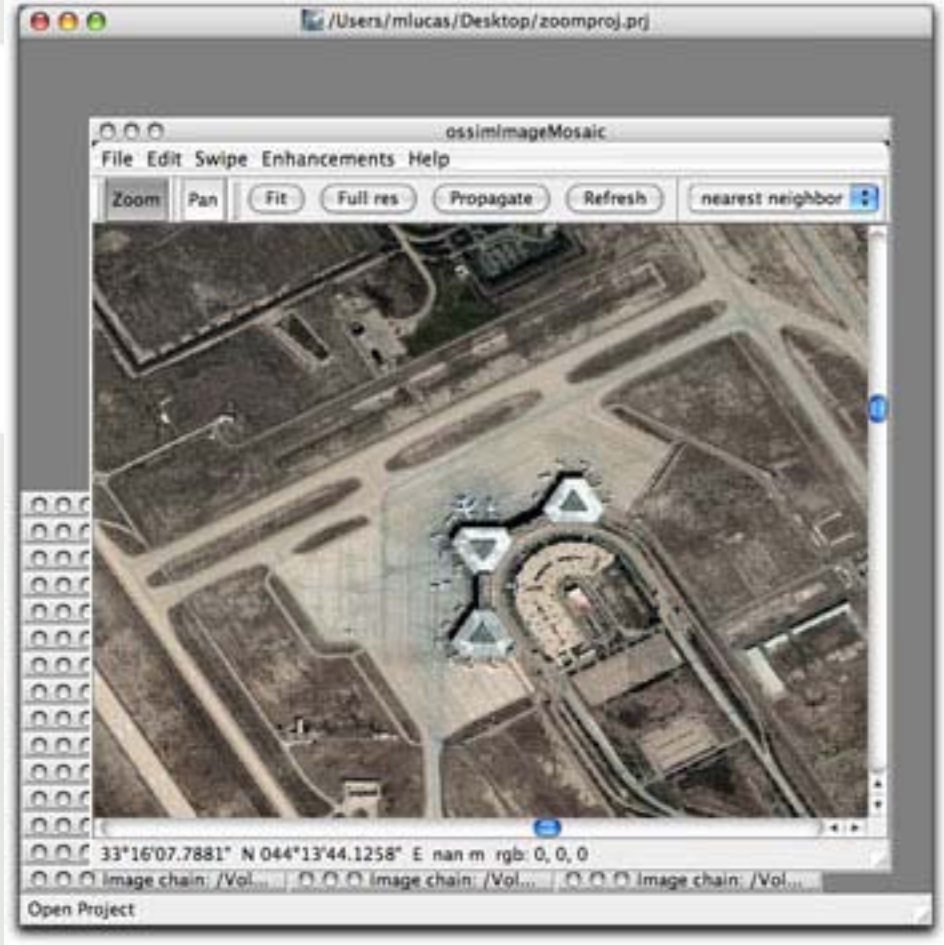
OSSIM

meter


/Users/mlucas/Desktop/zoomproj.prj
ossimImageMosaic
File Edit Swipe Enhancements Help
Zoom
Pan
Fit
Full res
Propagate
Refresh
nearest neighbor
33°16'07.3780" N 044°13'41.3719" E nan m rgb: 0, 0, 0
Image chain: /Vol...
Image chain: /Vol...
Image chain: /Vol...
Open Project

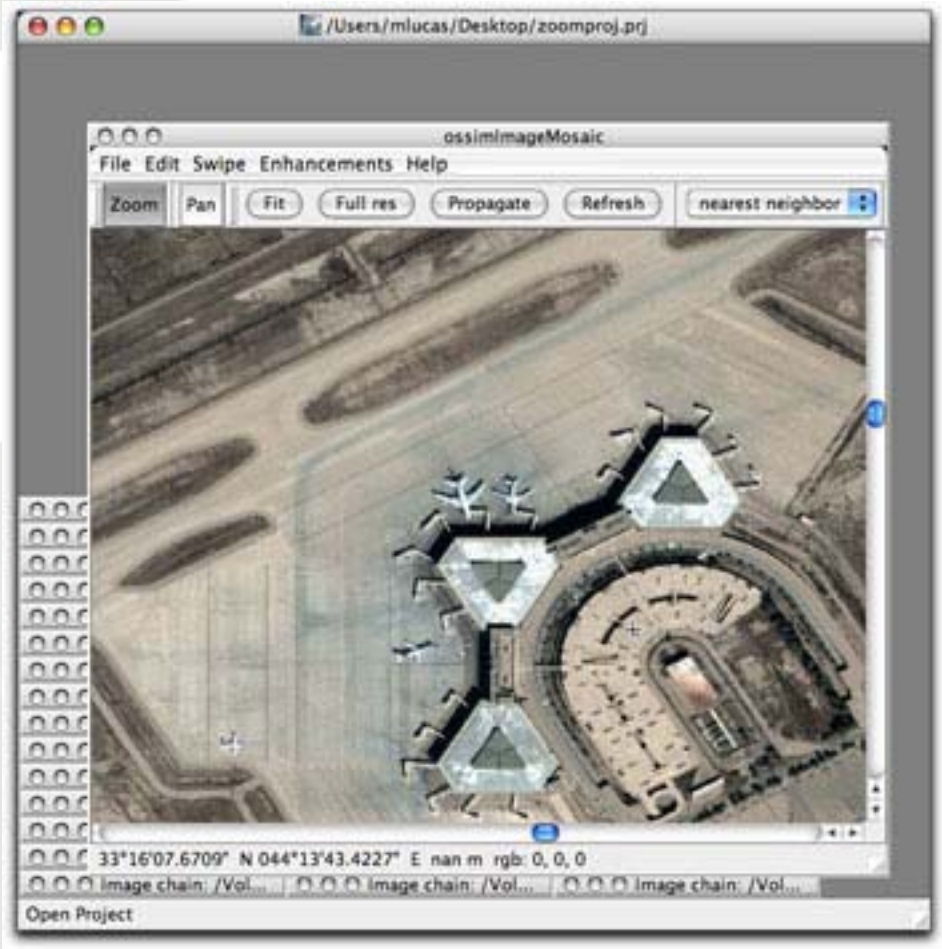
OSSIM

Very Large Mosaics



OSSIM

2.5 Meter

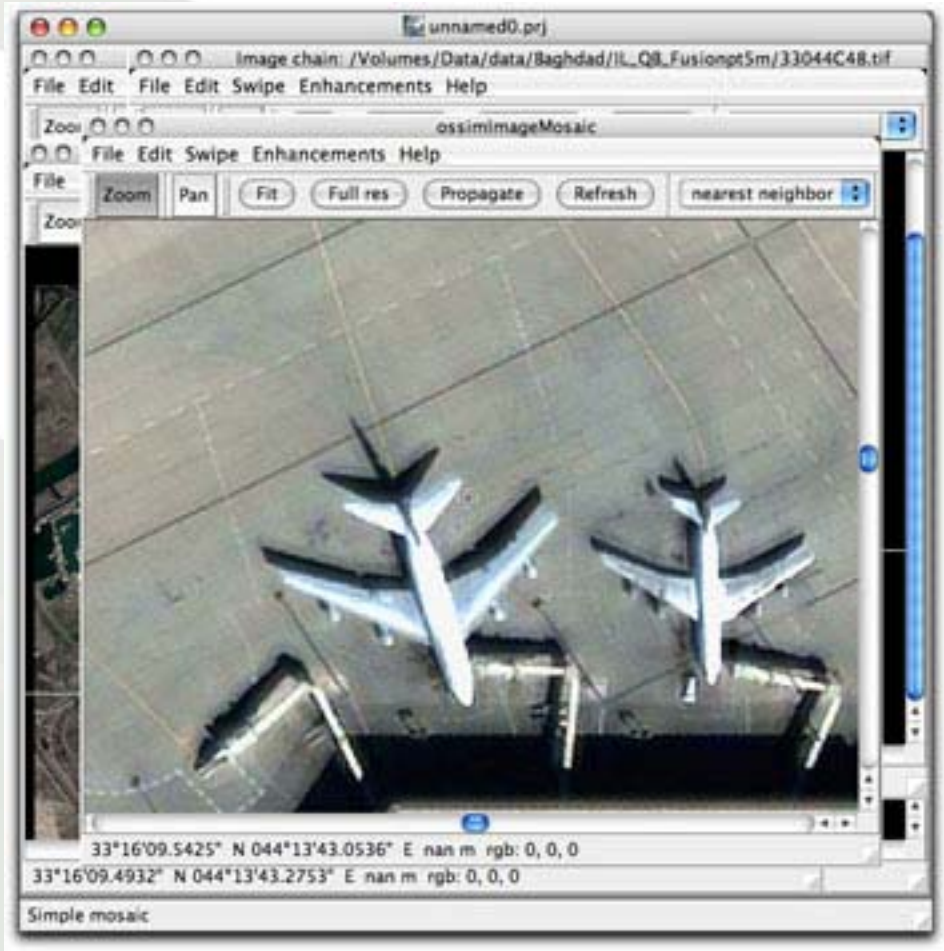


OSSIM

1 Meter

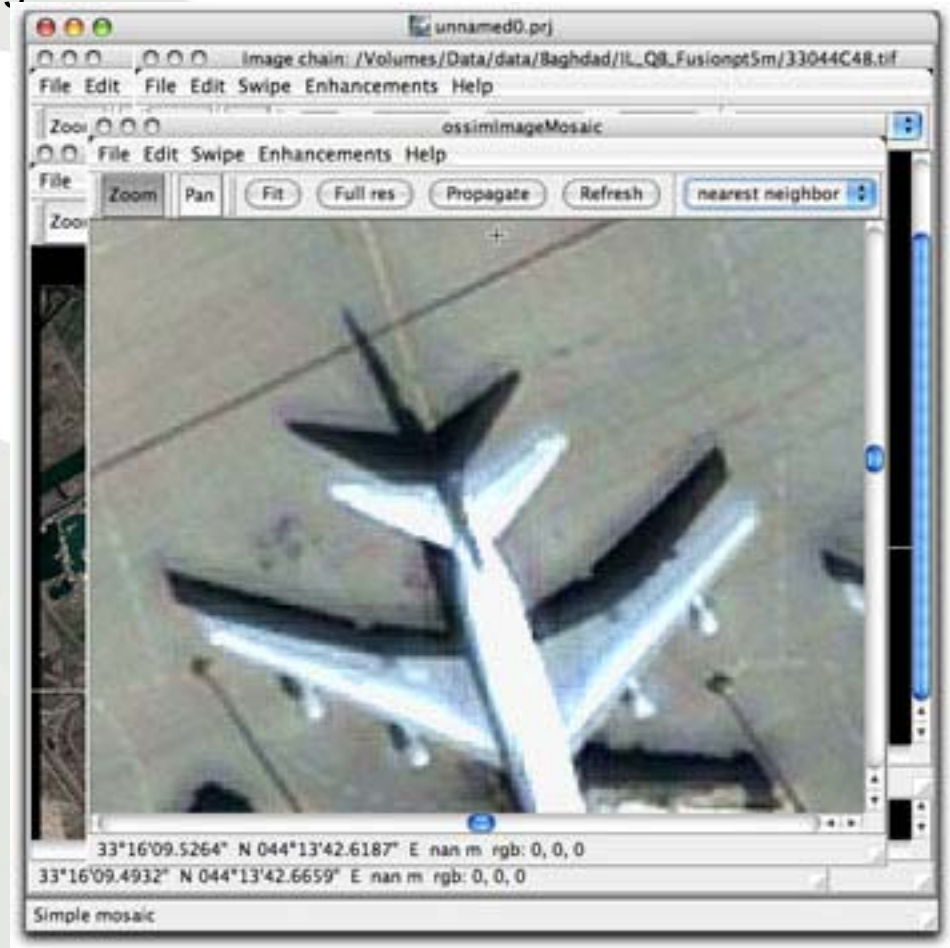
OSSIM

0.5 Meter



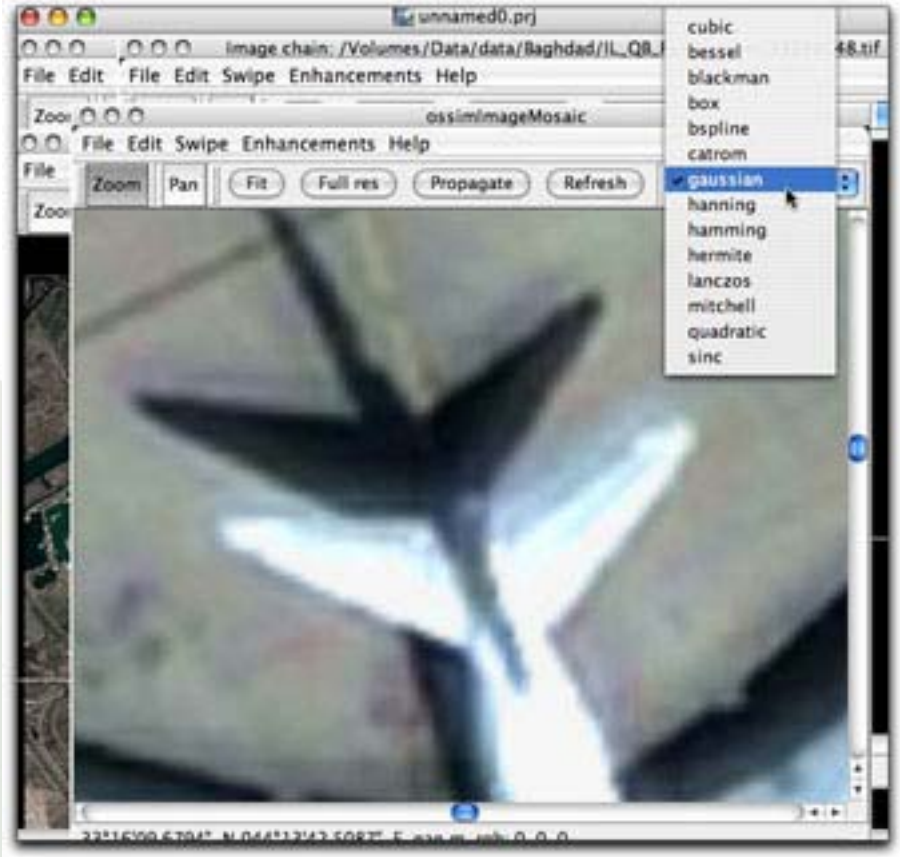
OSSIM

Super Sampling



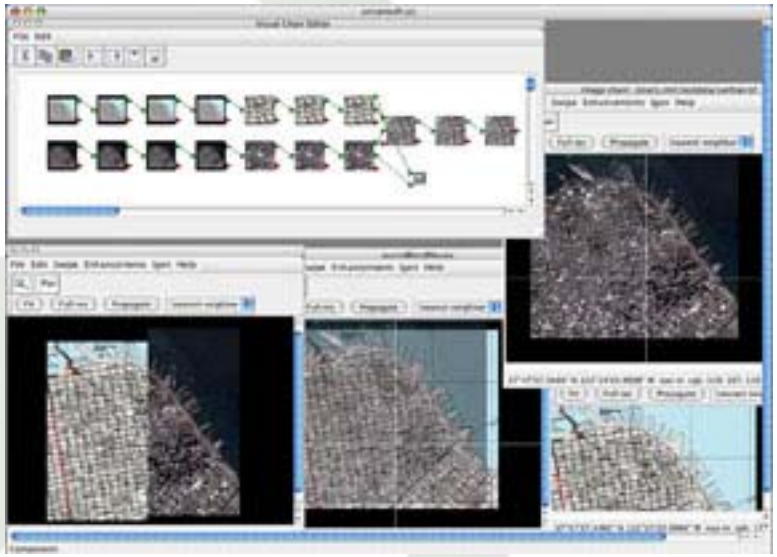
OSSIM

Various resamplers



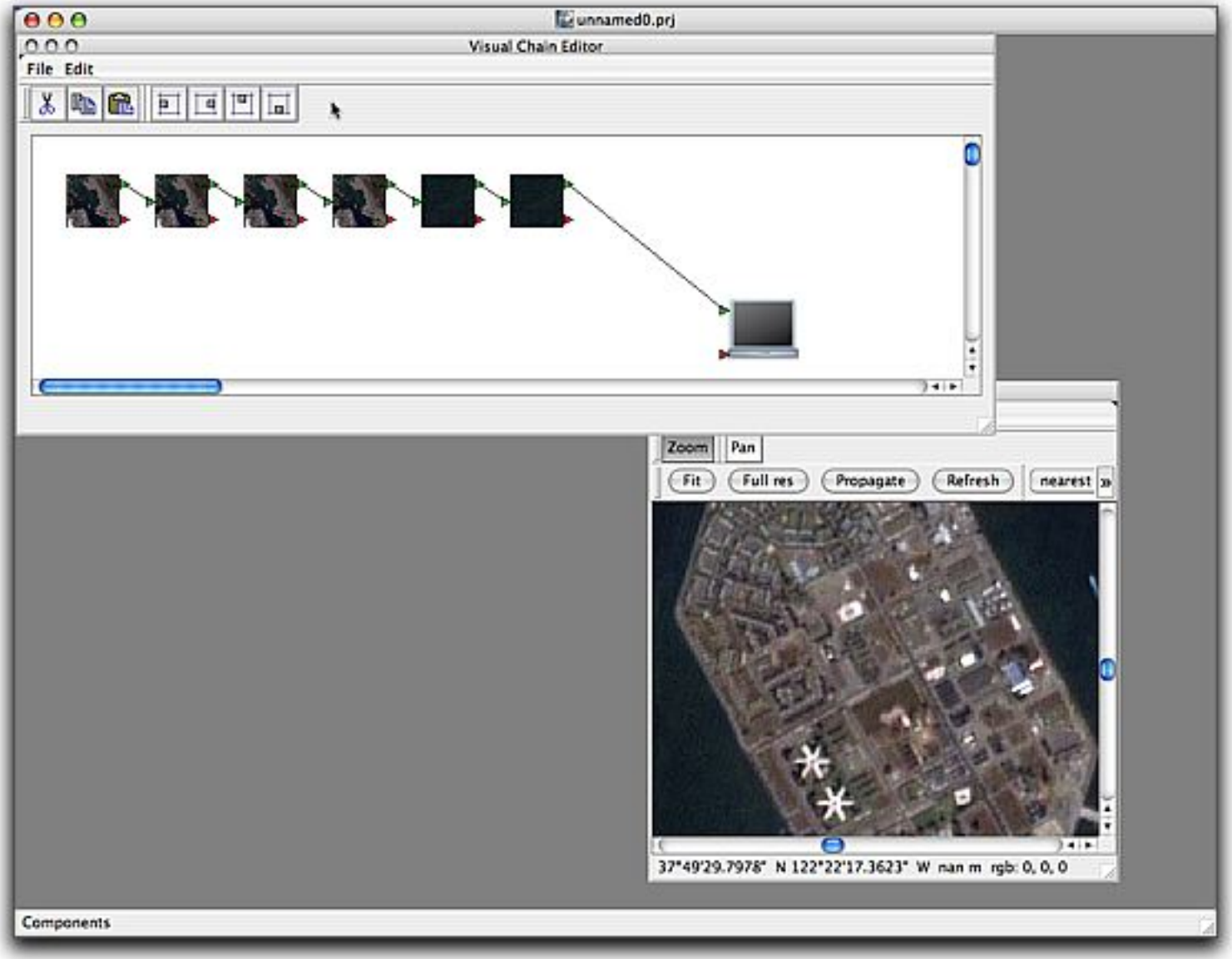
OSSIM

Advanced Prototyping



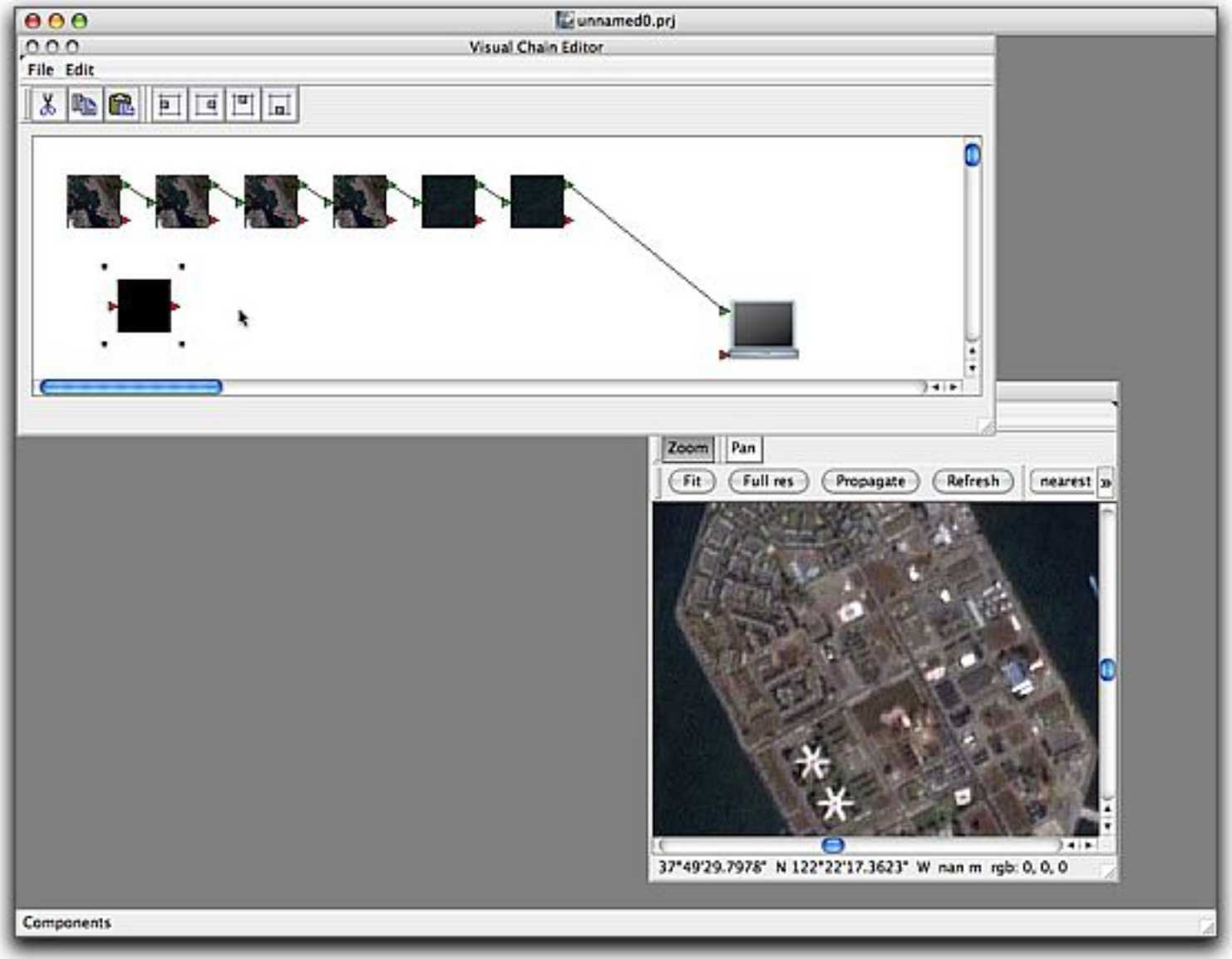
OSSIM

Visual Chain Editor

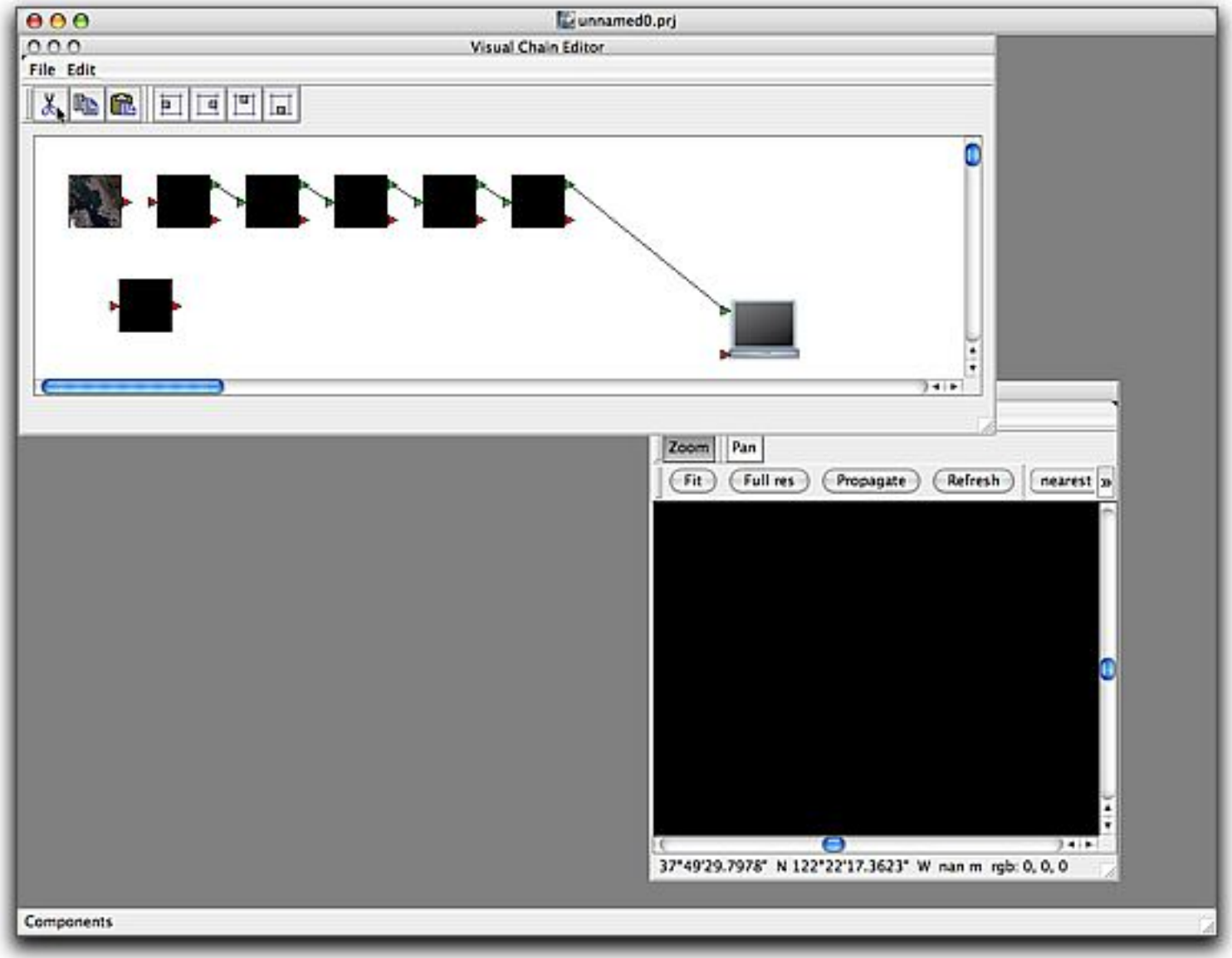


Edge Filter

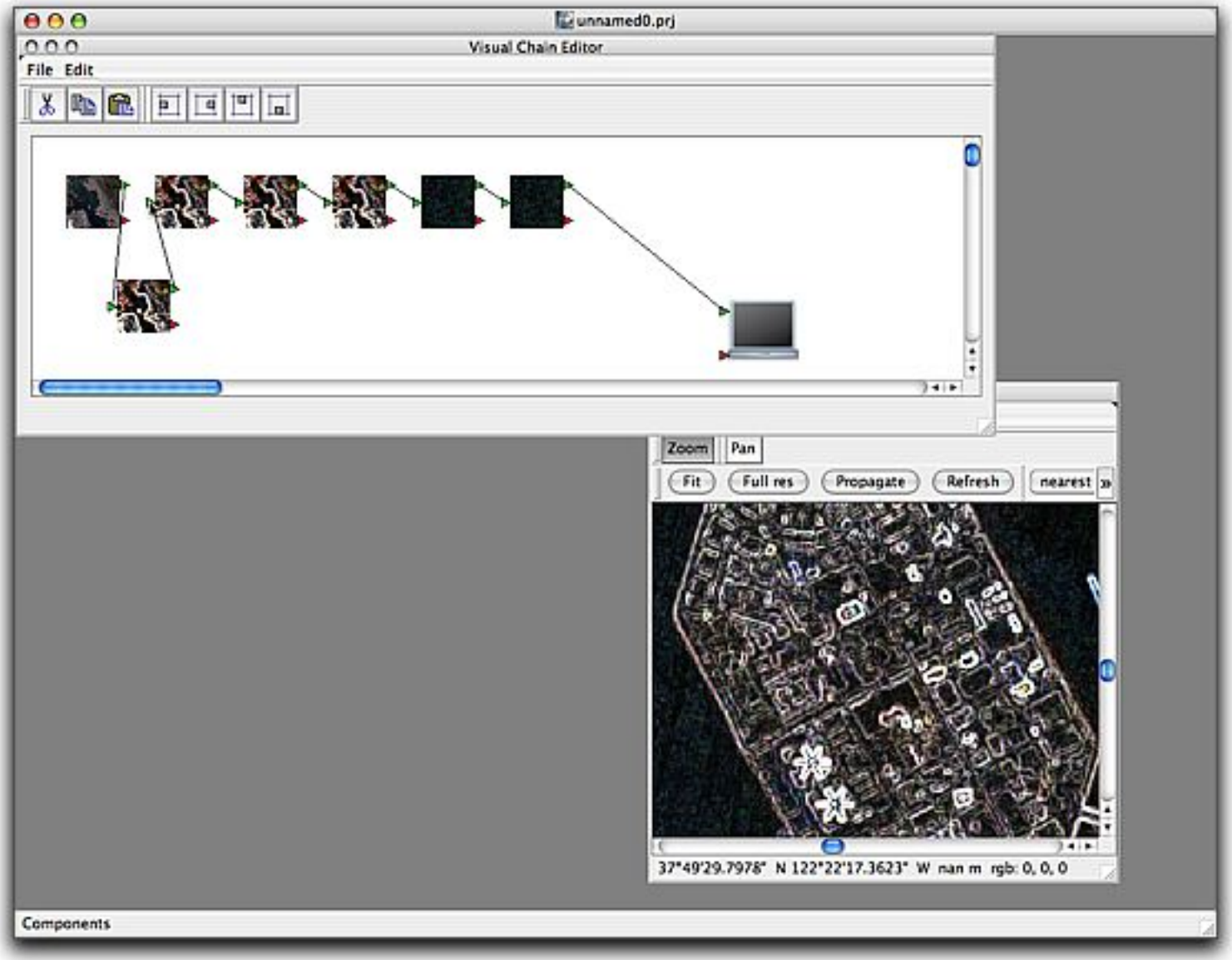
OSSIM



OSSIM

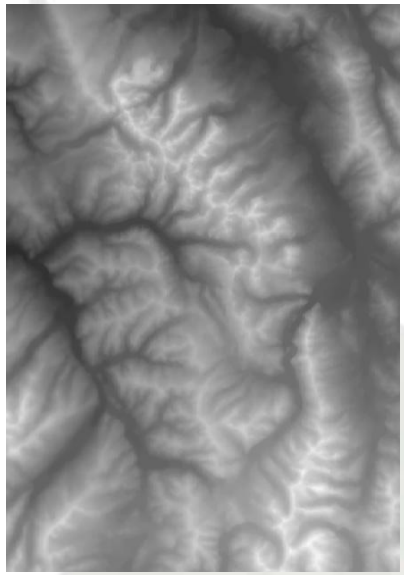

unnamed0.prj
Visual Chain Editor
File Edit
Zoom
Pan
Fit
Full res
Propagate
Refresh
nearest
37°49'29.7978" N 122°22'17.3623" W nan m rgb: 0, 0, 0
Components

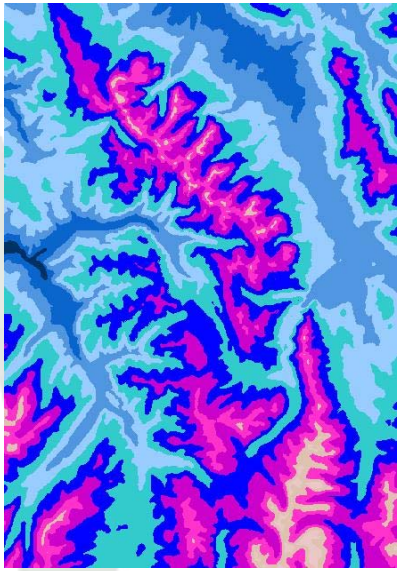
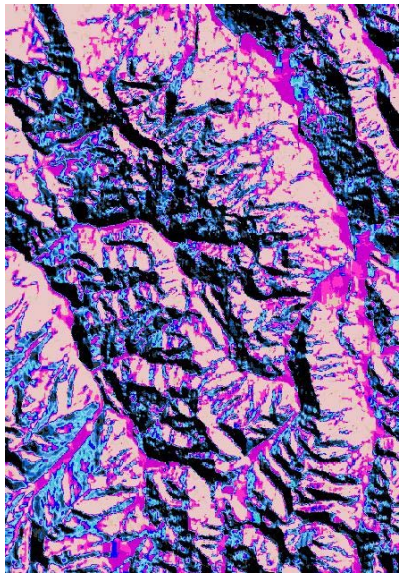
OSSIM


unnamed0.prj
Visual Chain Editor
File Edit
Zoom
Pan
Fit
Full res
Propagate
Refresh
nearest
37°49'29.7978" N 122°22'17.3623" W nan m rgb: 0, 0, 0
Components

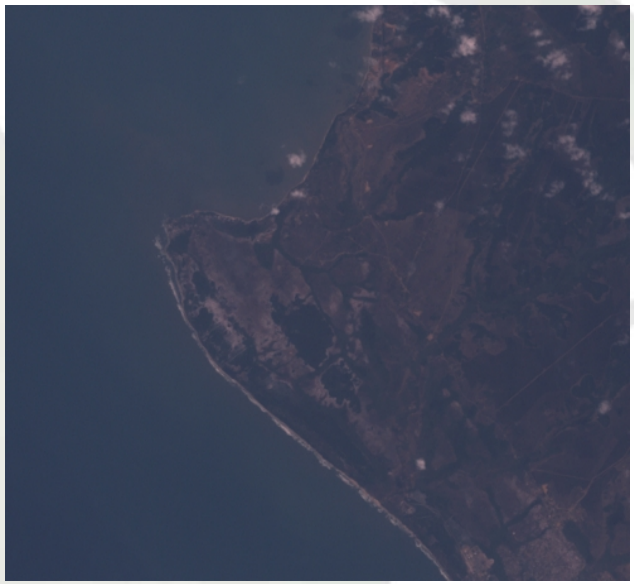
Polygon Masking

Elevation Processing

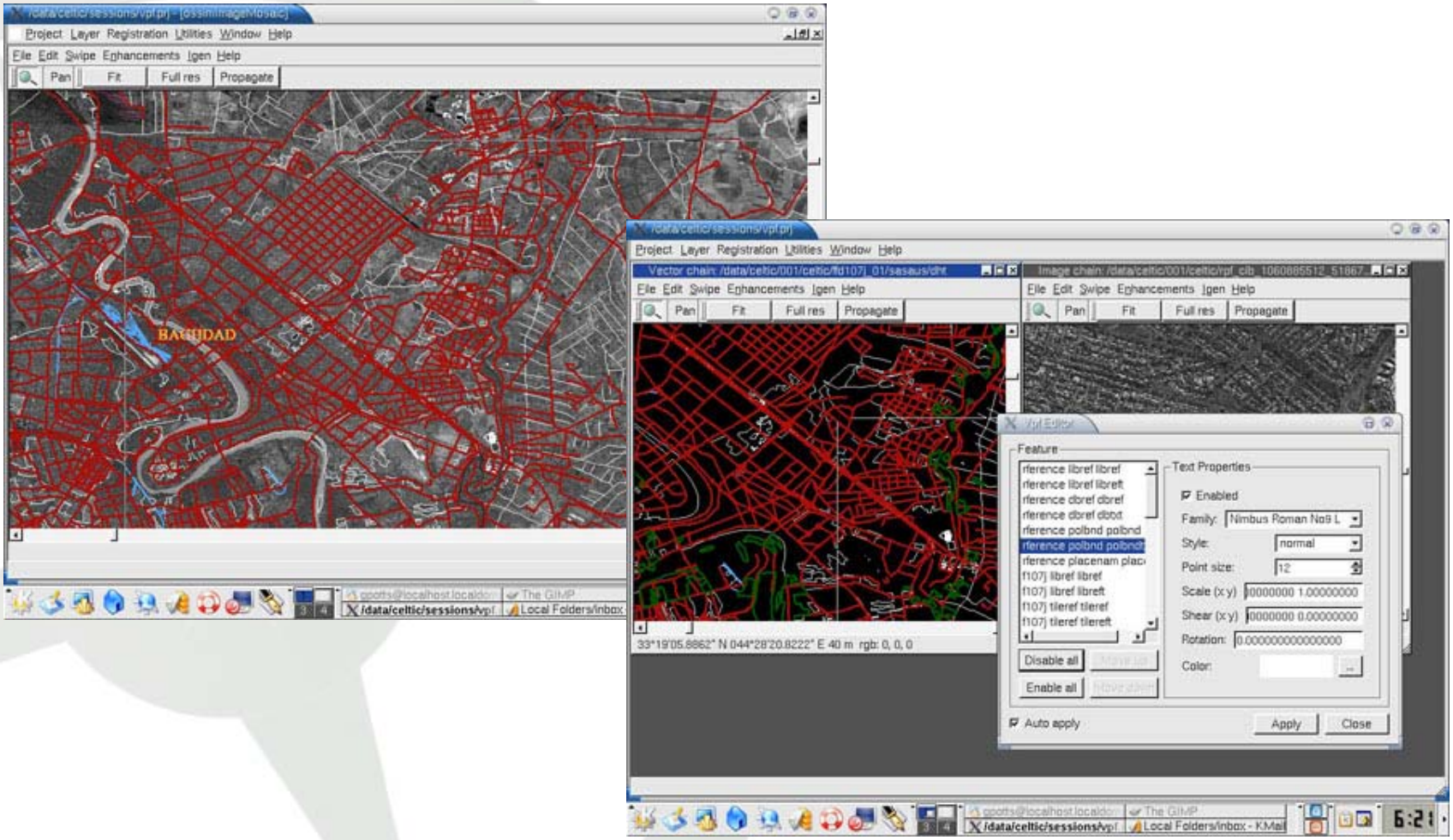


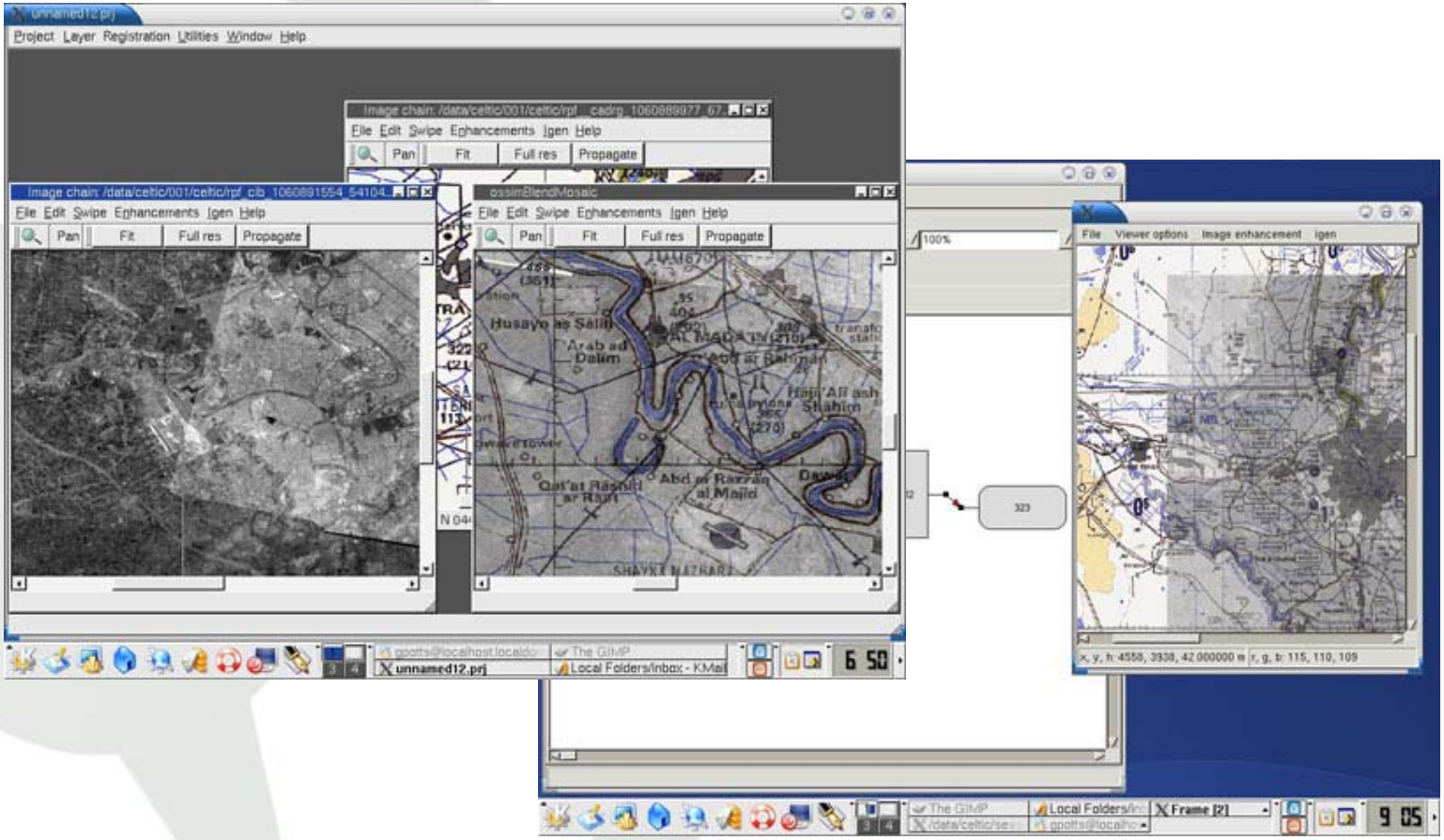
Equation Editor



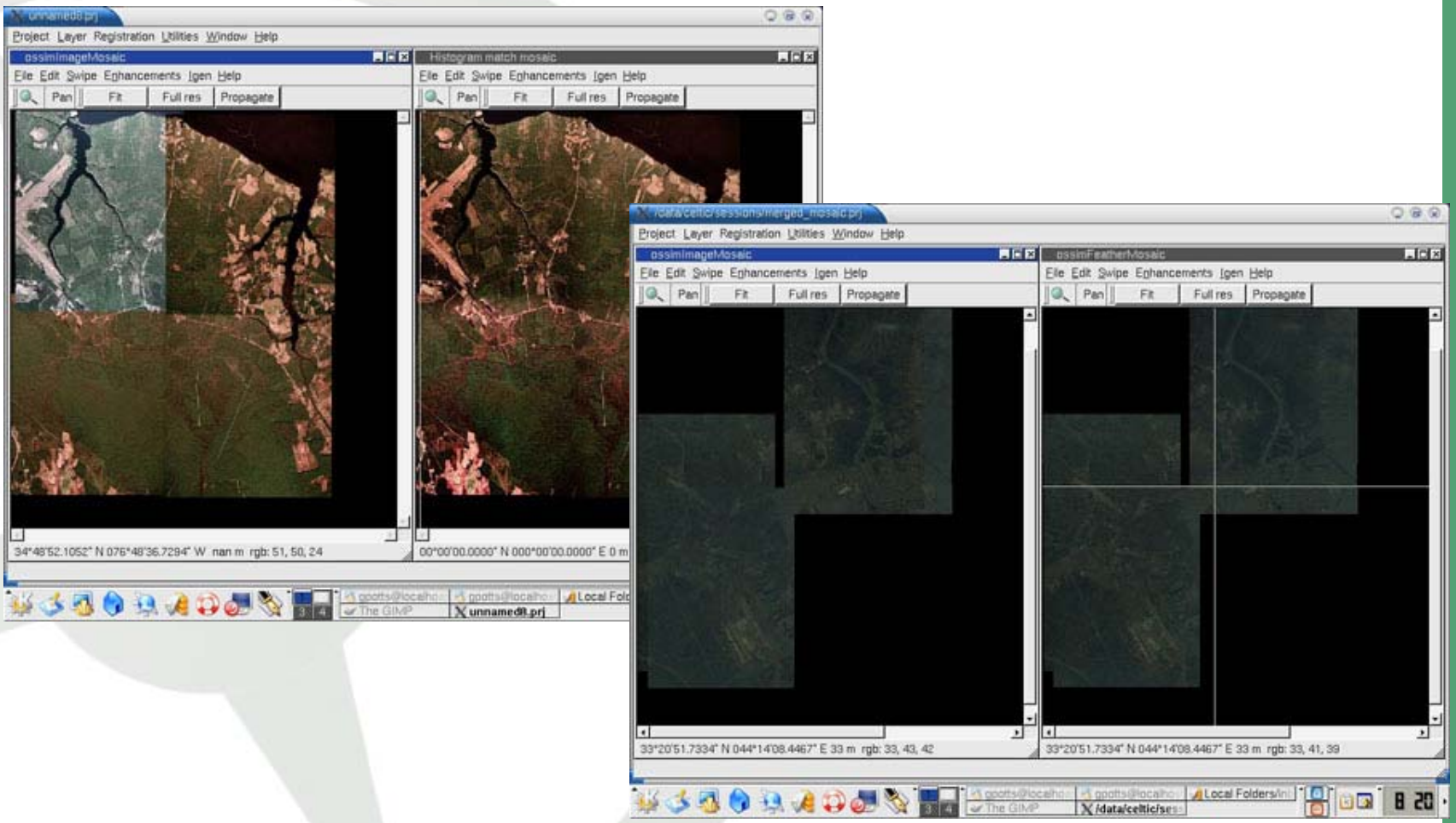
Vector Support



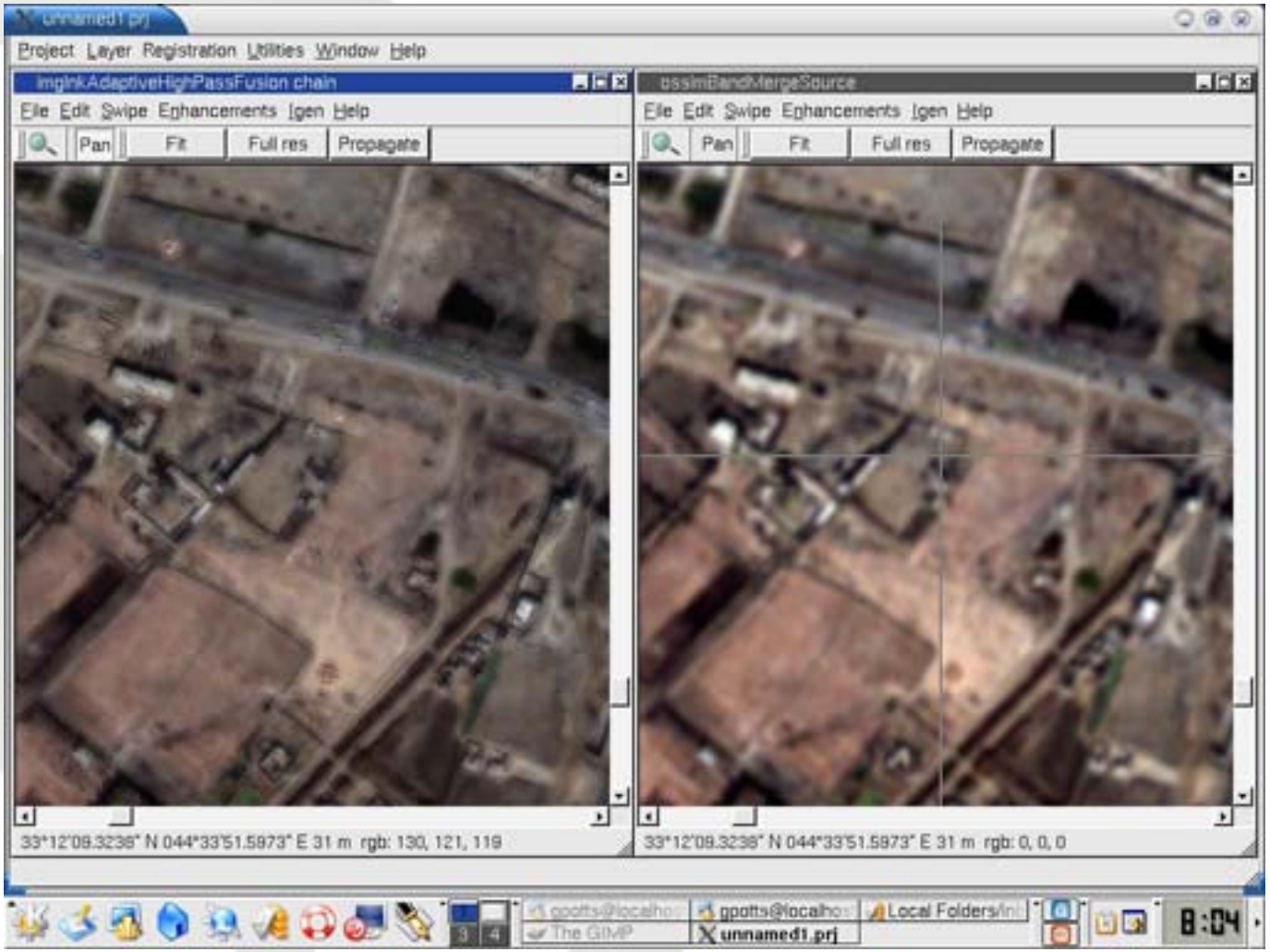
Blends


Project Layer Registration Utilities Window Help
File Edit Swipe Enhancements Igen Help
Pan
Fit
Full res
Propagate
Image chain: /data/celtic/001/celtic/rpf_clb_1060891554_54104...
ossimBlendMosaic
Husayo as Salih
Arab ad Dalim
Qal'at Rashid ar Rawi
Abd ar Razzaq al Maiid
SHAYKH NAZHARI
unnamed12.prj
Local Folders/Inbox - K-Mail
6 50
File Viewer options Image enhancement Igen
100%
323
Frame [2]
9 05

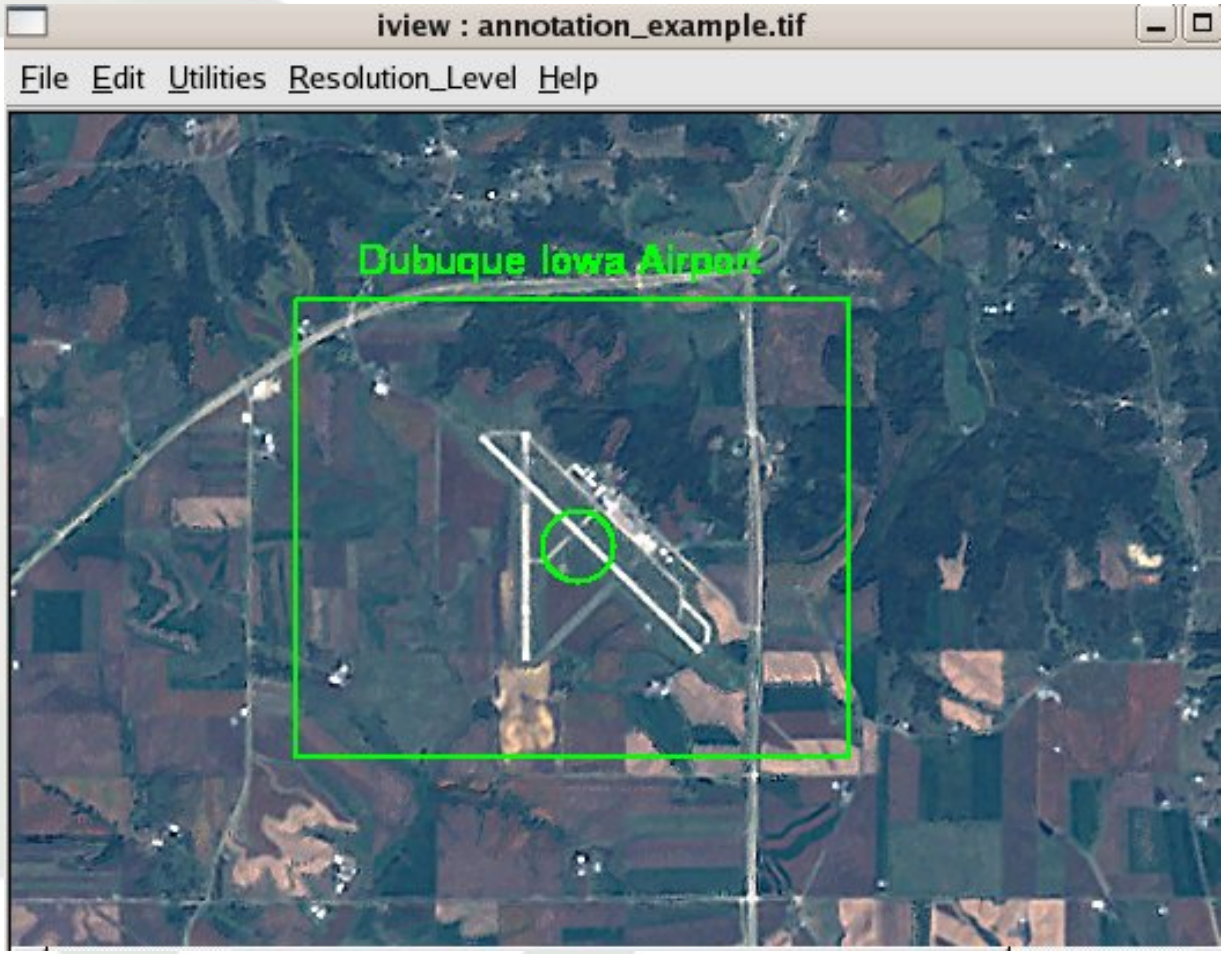
Mosaics and Histogram Matching



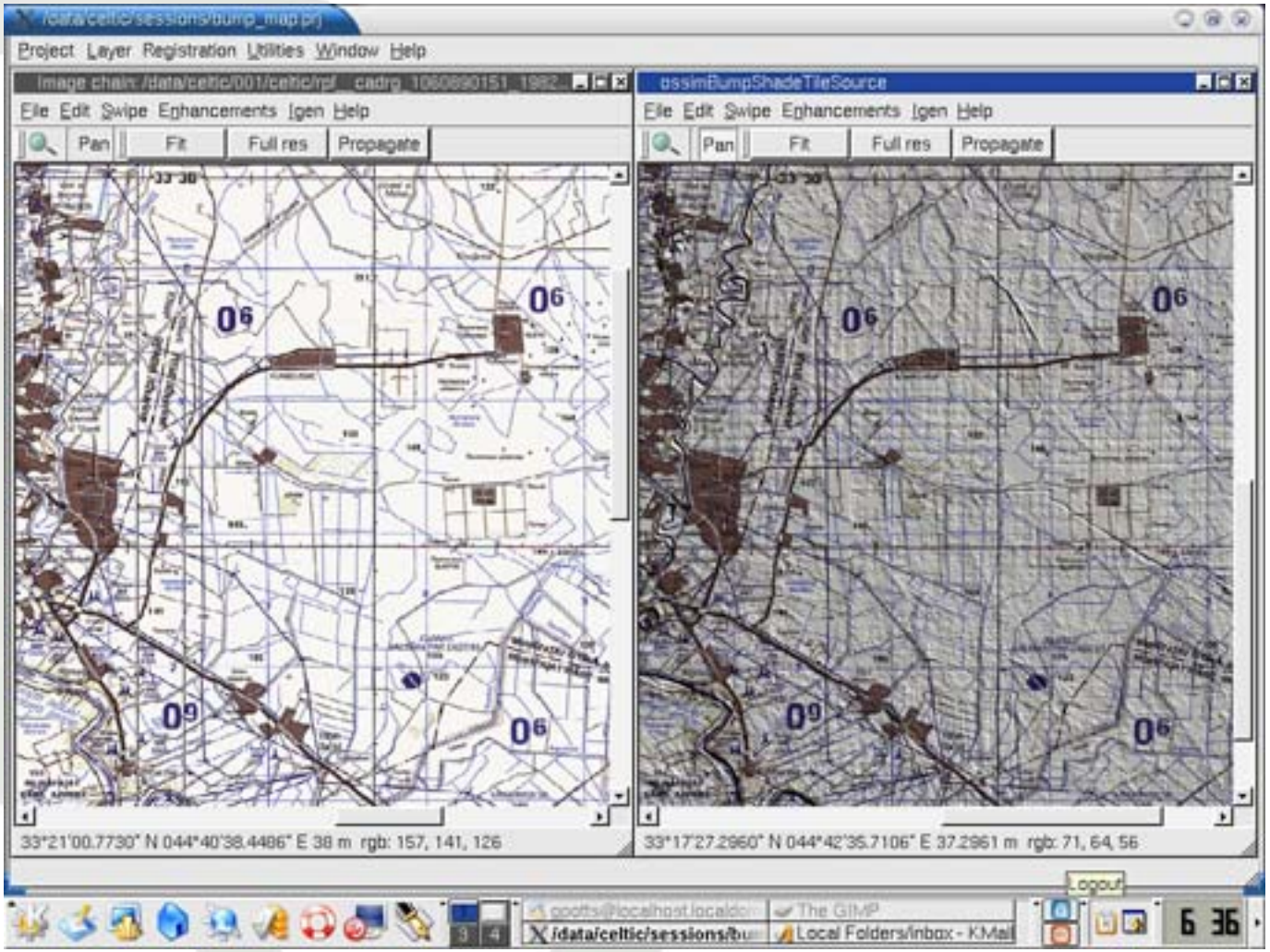
OSSIM


unnamed1.prj
Project Layer Registration Utilities Window Help
imgInkAdaptiveHighPassFusion chain
File Edit Swipe Enhancements Igen Help
Pan Fit Full res Propagate
33°12'09.3236" N 044°33'51.5973" E 31 m rgb: 130, 121, 119
ossimBandMergeSource
File Edit Swipe Enhancements Igen Help
Pan Fit Full res Propagate
33°12'09.3236" N 044°33'51.5973" E 31 m rgb: 0, 0, 0
gpotts@localho
The GIMP
gpotts@localho
unnamed1.prj
Local Folders
8:04

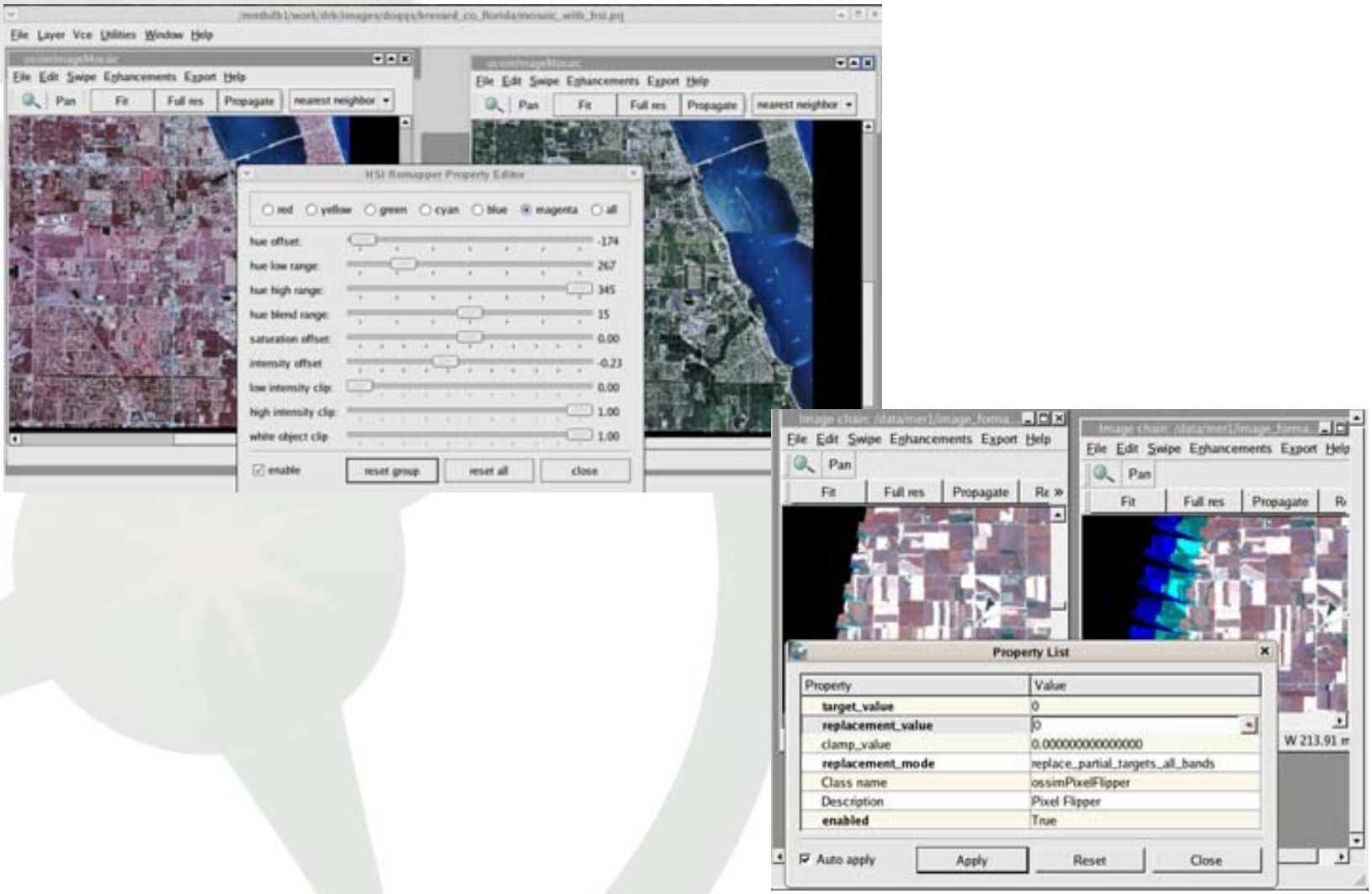
OSSIM


iview : annotation_example.tif
File Edit Utilities Resolution_Level Help
Dubuque Iowa Airport

OSSIM


Project Layer Registration Utilities Window Help
File Edit Swipe Enhancements Igen Help
Pan
Fit
Full res
Propagate
ossimBumpShadeTileSource
33°21'00.7730" N 044°40'38.4486" E 38 m rgb: 157, 141, 126
33°17'27.2960" N 044°42'35.7106" E 37.2961 m rgb: 71, 64, 56
Logout

OSSIM


File Layer Vce Utilities Window Help
File Edit Swipe Enhancements Export Help
Pan
Fit
Full res
Propagate
nearest neighbor
HSI Remapper Property Editor
red
yellow
green
cyan
blue
magenta
all
hue offset
hue low range
hue high range
hue blend range
saturation offset
intensity offset
low intensity clip
high intensity clip
white object clip
enable
reset group
reset all
close
Property List
Property
Value
target_value
replacement_value
clamp_value
replacement_mode
Class name
Description
enabled
Auto apply
Apply
Reset
Close

OSSIM


unnamed0.prj
File Layer Vce Utilities Window Help
Image chain: /mnthdb1/work/dtb/image_formats/celric/018/po_106002_pan_0000000.ntf
File Edit Swipe Enhancements Export Help
Pan
Fit
Full res
Propagate
Refresh
nearest neighbor
imagelinker
Lat: 33°18'30.1065" N
Lon: 044°23'21.1425" E
Lat: 33.308362942018114
Lon: 44.389206271348911
Height: -2.1238347003811233
MSL Height: nan
Utm zone: 38
rgb: 46 46 46
hue: 46.00000262260437
Sat: 0
Int: 46.000001057982445
band 0: 371
33°18'30.1065" N 044°23'21.1425" E -2.12383 m rgb: 46, 46, 46

osgPlanet

Similar to Google Earth and NASA World Wind, main focus..

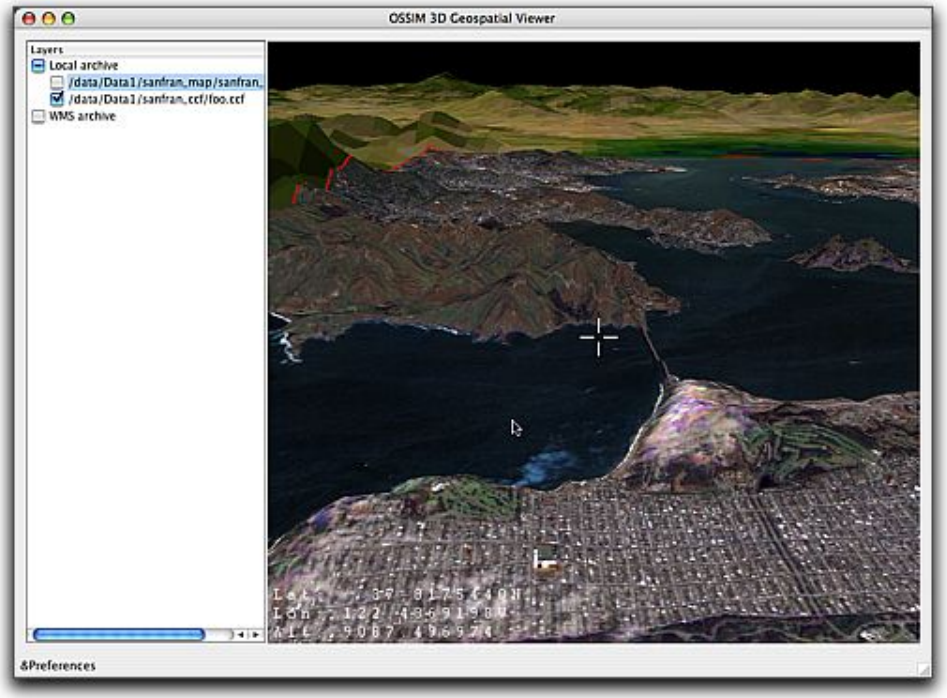
Open Source Software runs on multiple platforms

Photogrammetric Accuracy

Native file access, does not require precooked layers

OGC WMS compliance for Distributed access

Builds on top of OSSIM and OpenSceneGraph

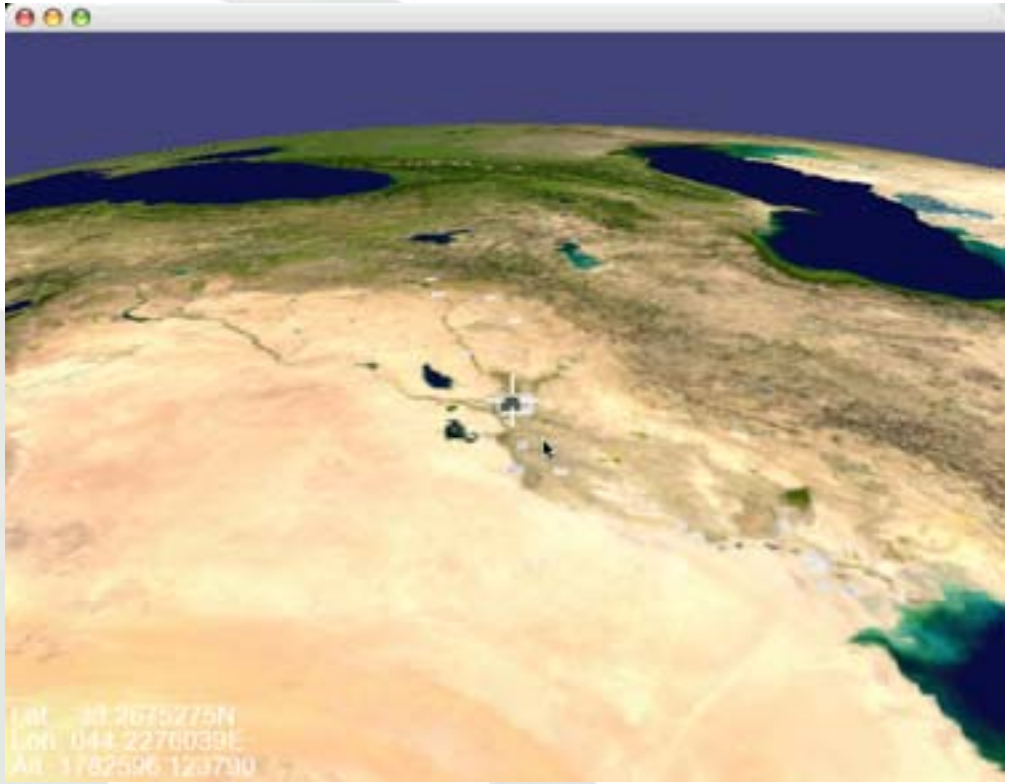


OSSIM

Advanced Visualization osgPlanet

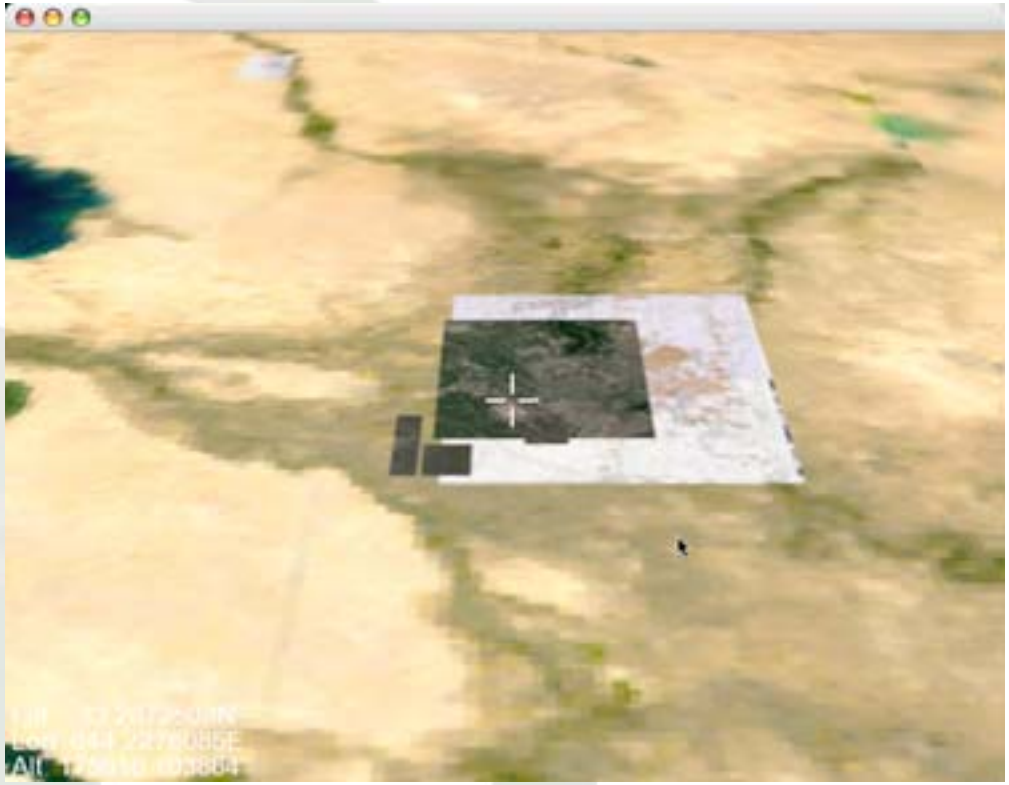
OSSIM

Advanced Visualization osgPlanet



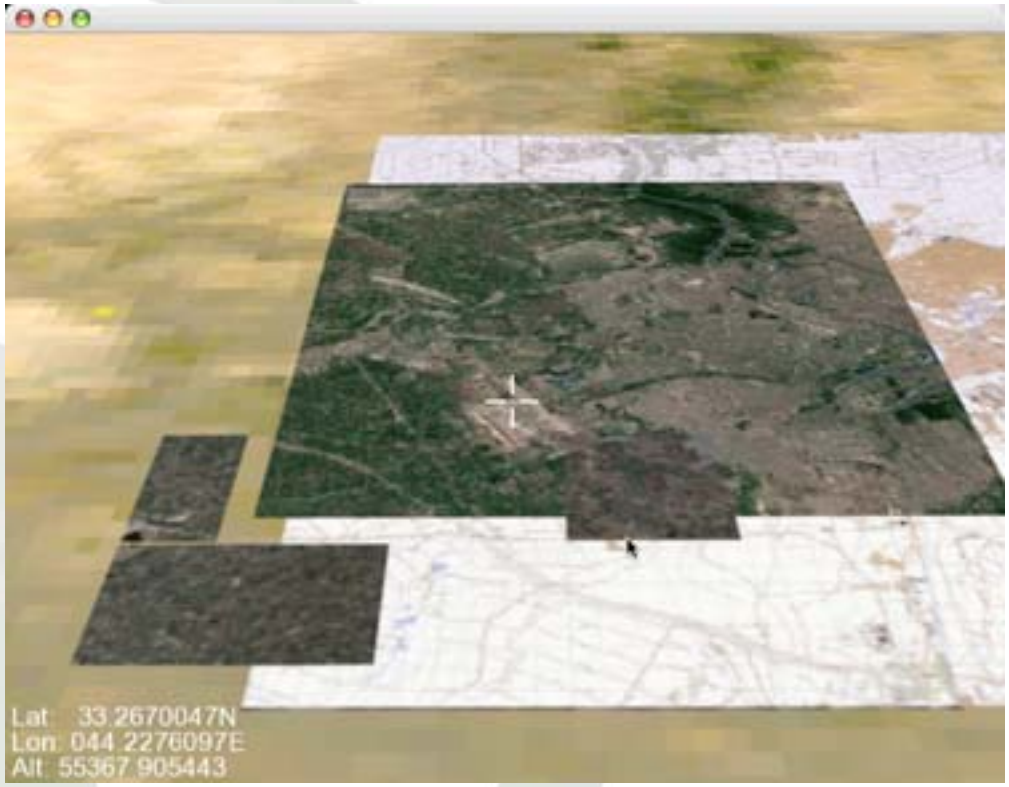
OSSIM

Advanced Visualization osgPlanet



OSSIM

Advanced Visualization osgPlanet



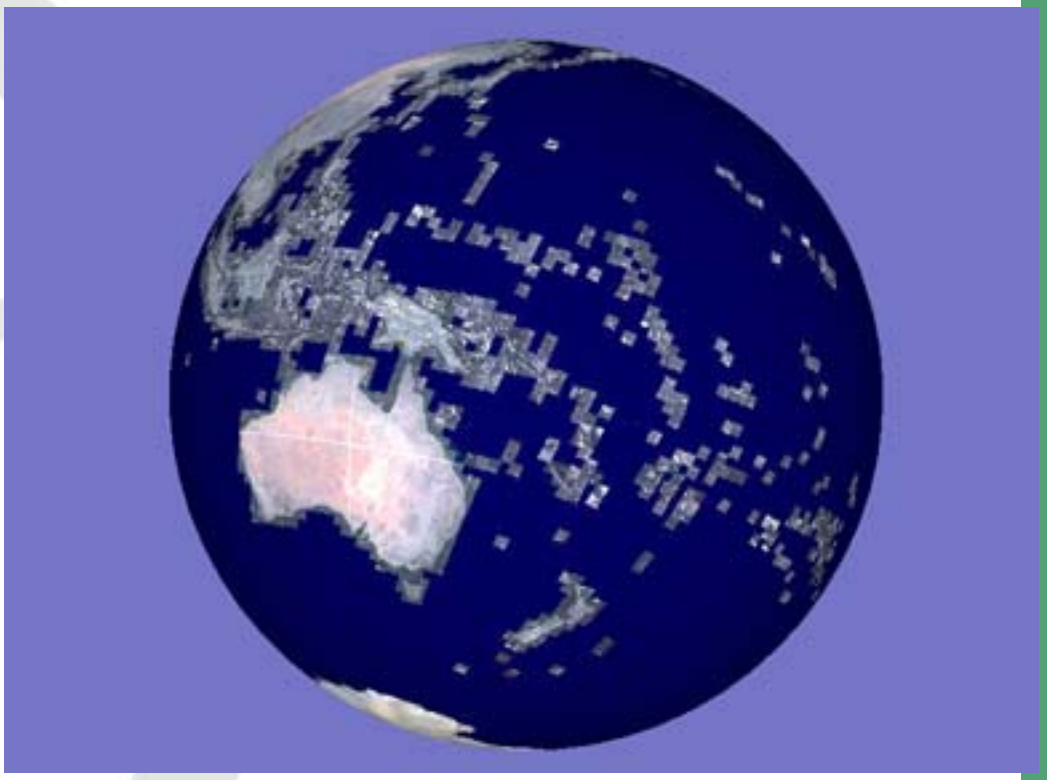
OSSIM

Advanced Visualization osgPlanet

OSSIM

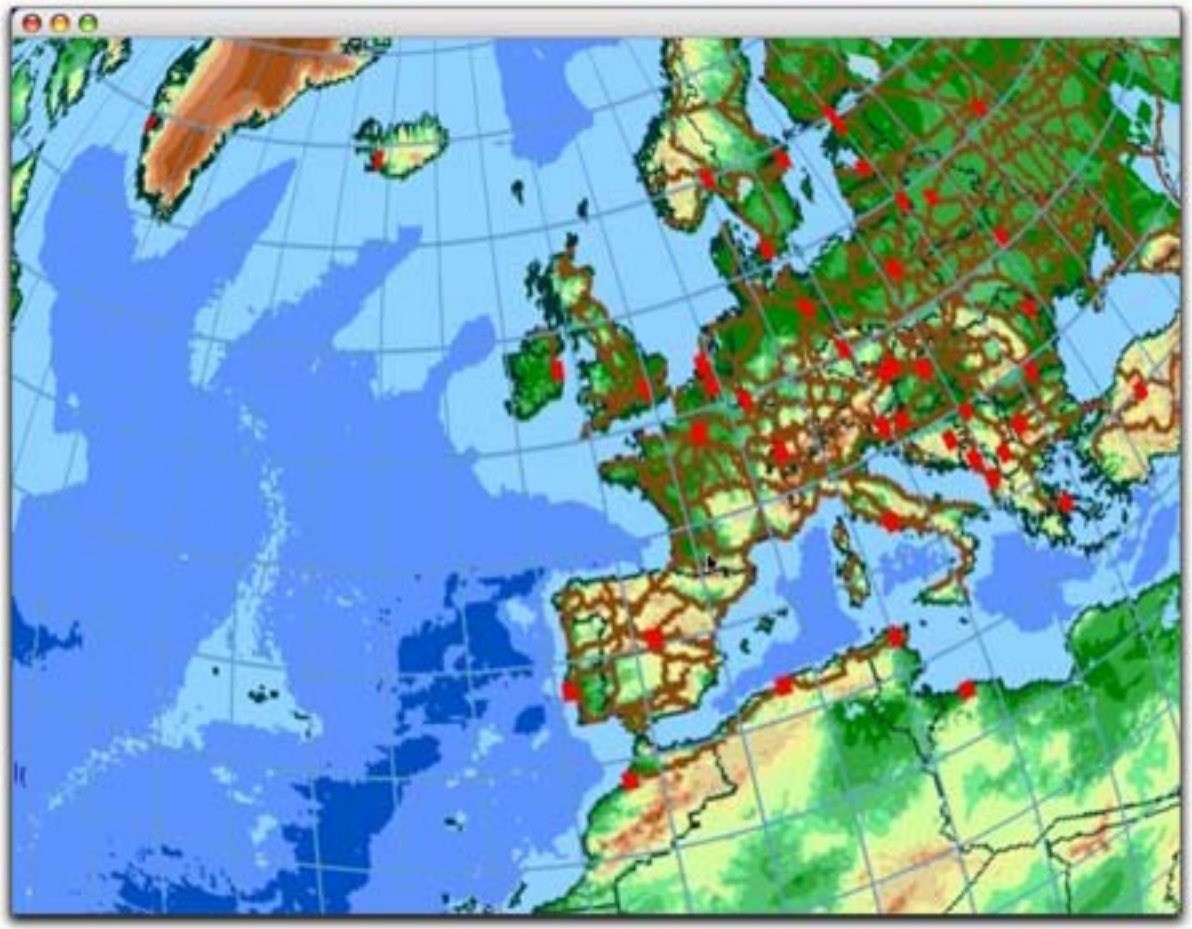
OGC Web Mapping Service Interface

NASA JPL



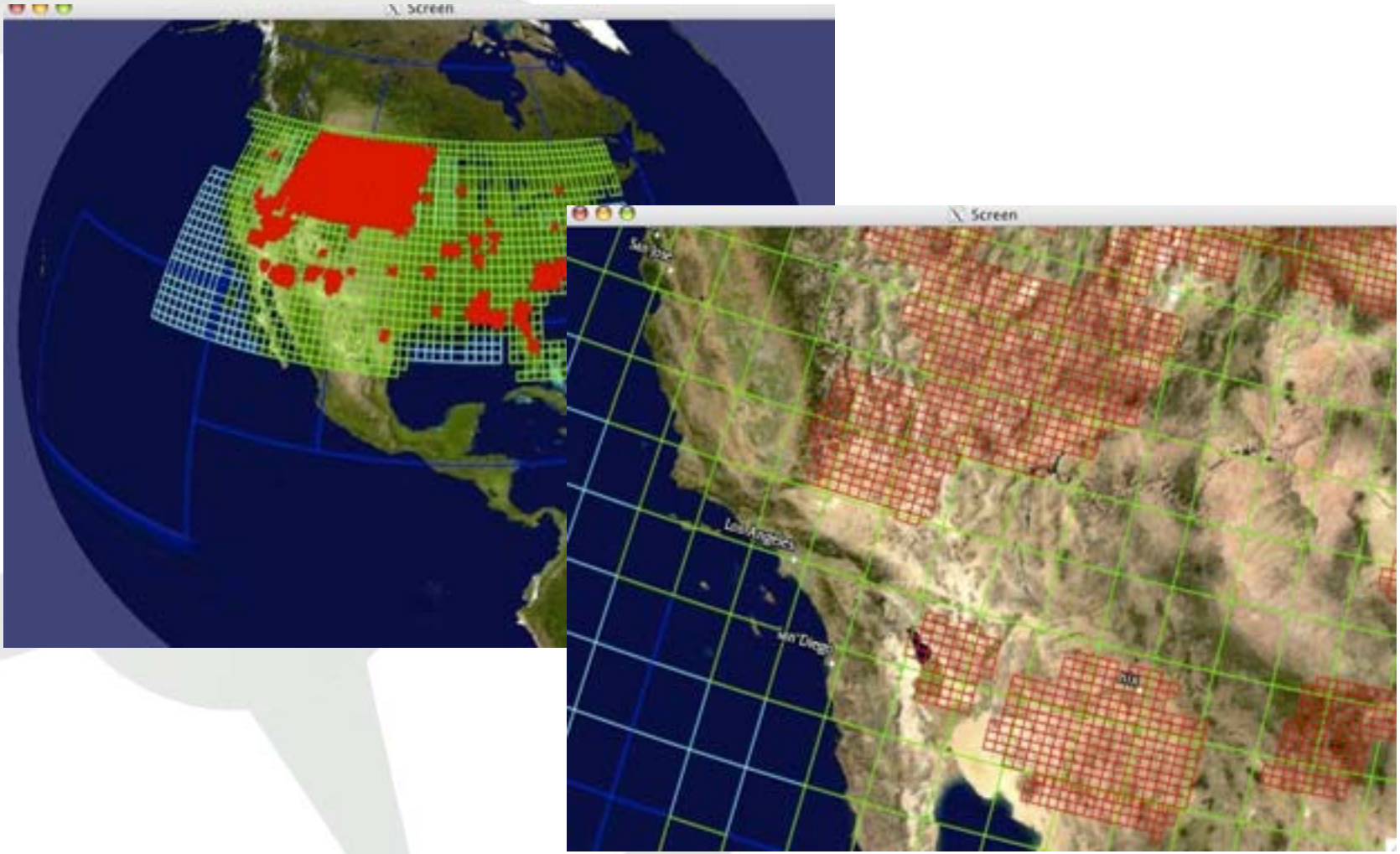
OSSIM

OGC Web Mapping Service Interface



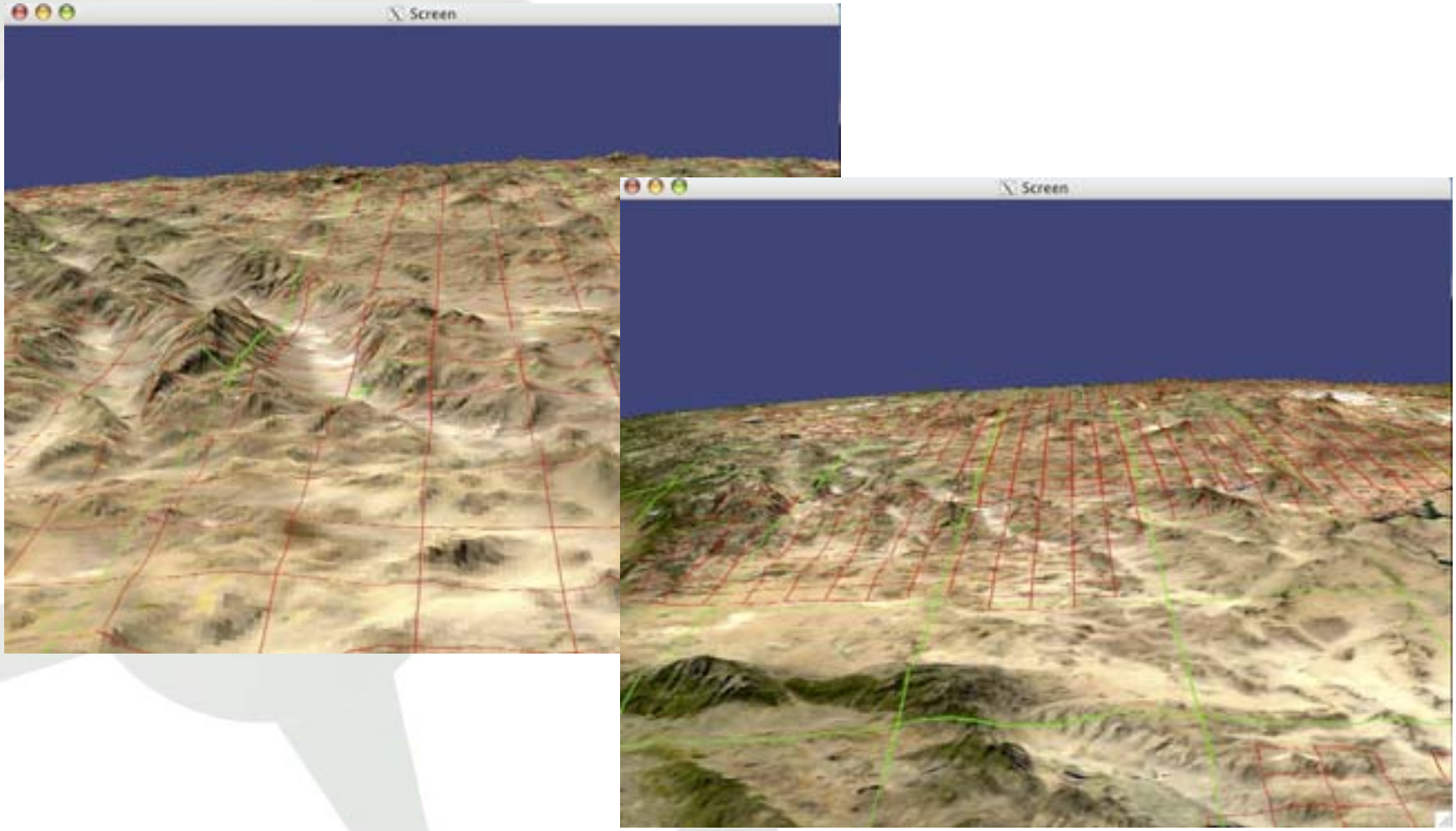
OSSIM

OGC Web Feature Service Interface



OSSIM

OGC Web Feature Service Interface

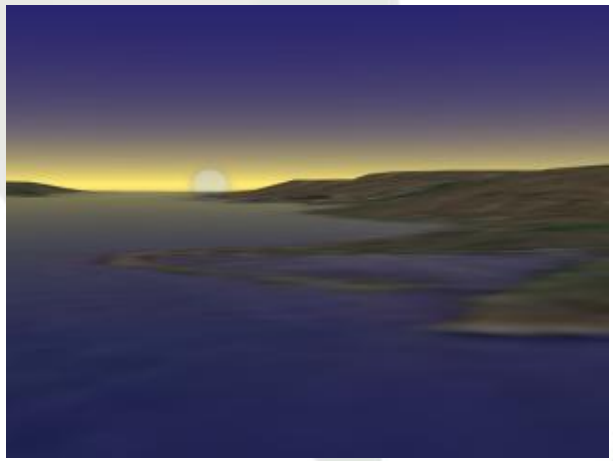


Open Technology Development Leverage

osgPlanet
- OSSIM
- OpenSceneGraph
- OGC WMS
- World Wind Servers

NRL MOADB
- Manipulators
- Navigation
- Hot Links
- Algorithmic Improvements

osgEphemeris
QGIS
Delta3D



MapGuide
MapServer
GRASS
Postgres/PostGIS
GeoServer
uDig
OpenLayers
GeoRSS

OSSIM

Contact Info

www.osgeo.org

www.ossim.org

Decision & Analysis as a Disruptive Technology

Seeing and Acting Beyond the "Horizon"

Desmond Saunders-Newton

BAE SYSTEMS AIT
Intelligence Innovation Division
Director, Social Computation & Complexity

University of Southern California
School of Policy, Planning & Development
Adjunct Associate Professor

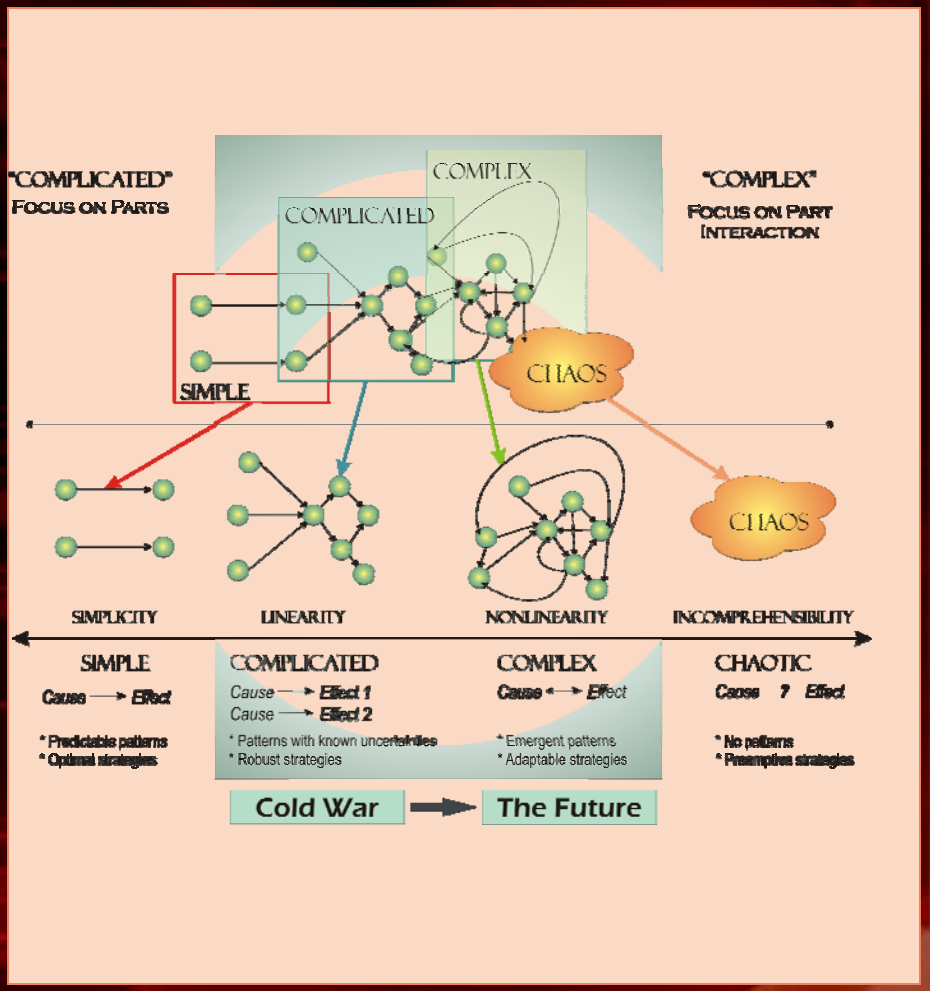
Disruptive Innovation

Disruptive Innovation … intentional or strategic employment of radical, novel or emerging approaches in a fashion that results in fundamental changes in capabilities, processes or outcomes.

- **General Posit** … analysis, and it's ability to support decision-making, constitutes an means to innovation
- **Specific Assertion** … inquiry approaches supported by advances in technology, primarily in informatics and "modeling, simulation & gaming," provides a means of achieving disruptive innovation
  - Beyond traditional notions of efficiency and effectiveness
  - Necessary approaches for dealing with longnow or "wicked hard" problems

Historical Precedents

- Decisions supported by an ability to ask questions about the world (analysis, synthesis, inquiry, etc.)
- Desire is to influence the world in a fashion to achieve goals of interest
  - Or, to at least avoid the “bad things” that could happen
- Policy analytic community provides an interesting example
  - Early 1900s, field was populated by individuals with training in law, divinity, etc.; or folks of social standing
  - 1920s, emergence of a “profession” largely populated by accountants
  - Emergence of policy analysis from ORSA community roots, occurred in the late 1960s
  - Late 1900s illustrated how practice has reached limitations
    - Inability to easily cleave “fact from value (context)”
    - *Complex* problems gained preeminence over *complicated* problems
  - What tools do we use now?

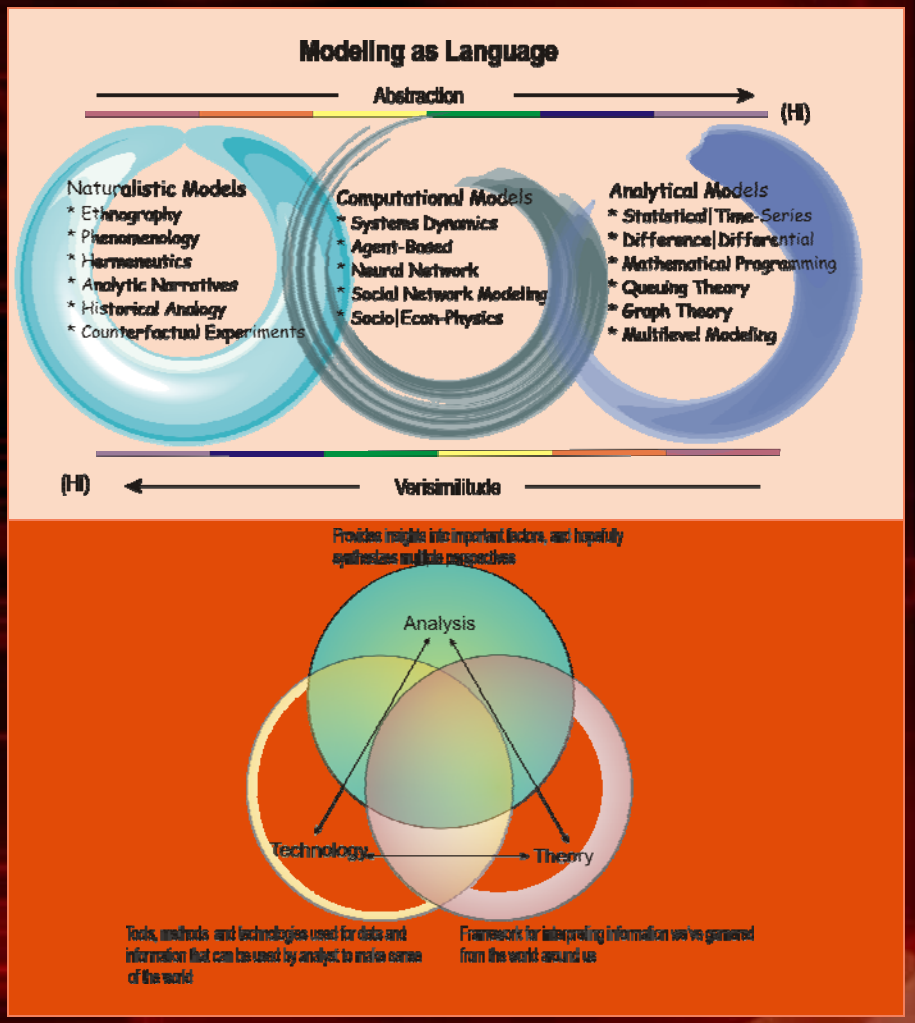


Disruption in the Realm of "Analysis & Decision"

- Analytic production
  - What is of importance to a decision-maker?
    - The ability to confirm "his or her" intuitions
    - Preponderance of evidence to support a "wow, who would have thought moment"
- Disruptive analytic capabilities would assure the above, but would also …
  - Support the consideration of highly "complex," or inter-coupled, problems
  - Give rise to ability to explore longer timelines
- "Shaping" capacity
  - **Shaping** … the ability to formulate and implement strategies or policies that give rise to a desired societal trajectory
  - Requires an ability to explore efficacious strategies, anticipated discontinuities, and co-evolutionary pressures
- Advanced analytics in support choice-making accounts for the capacity of a situation to change, or an adversary to learn
  - Advanced OODA-training

Commercial Possibilities

- Commercial possibilities arise from the Academy and the private sector
  - Revisiting the "body of human knowledge"
    - "Stuff" beyond the physical sciences
    - Interesting possibilities in the social and behavioral sciences
  - Consumers include the intelligence communities and C^2 staffs (strategic intelligence, consequence assessment, "strategy-task" v2.0)
- A focus area of note … advanced analytic (inquiry) technologies
  - Interesting business models emerge; analytic product is more important than technology artifact
  - Intuition augmented by formal notions of behavior



Actions by DOD

- Investments in the exploitation of the “social & behavioral” sciences
  - Note … fields are nascent compared to physical sciences, as well as different
    - Rate of return on investment is substantially greater than marginal improvements
    - Capacity is necessary, regardless of “youth”
    - Cool means of exploitation
      - “Six or so things to do with a bad model”
- Initial focus should be on insight-generation (enhancing the capacity of the analytic corps), and the ability to communicate complex ideas to decision-makers
  - Context (modeling)
  - Option Visualization
  - Collaboration

Decision & Analysis as a Disruptive Technology

Seeing and Acting Beyond the "Horizon"

Desmond Saunders-Newton

BAE SYSTEMS AIT
Intelligence Innovation Division
Director, Social Computation & Complexity

University of Southern California
School of Policy, Planning & Development
Adjunct Associate Professor

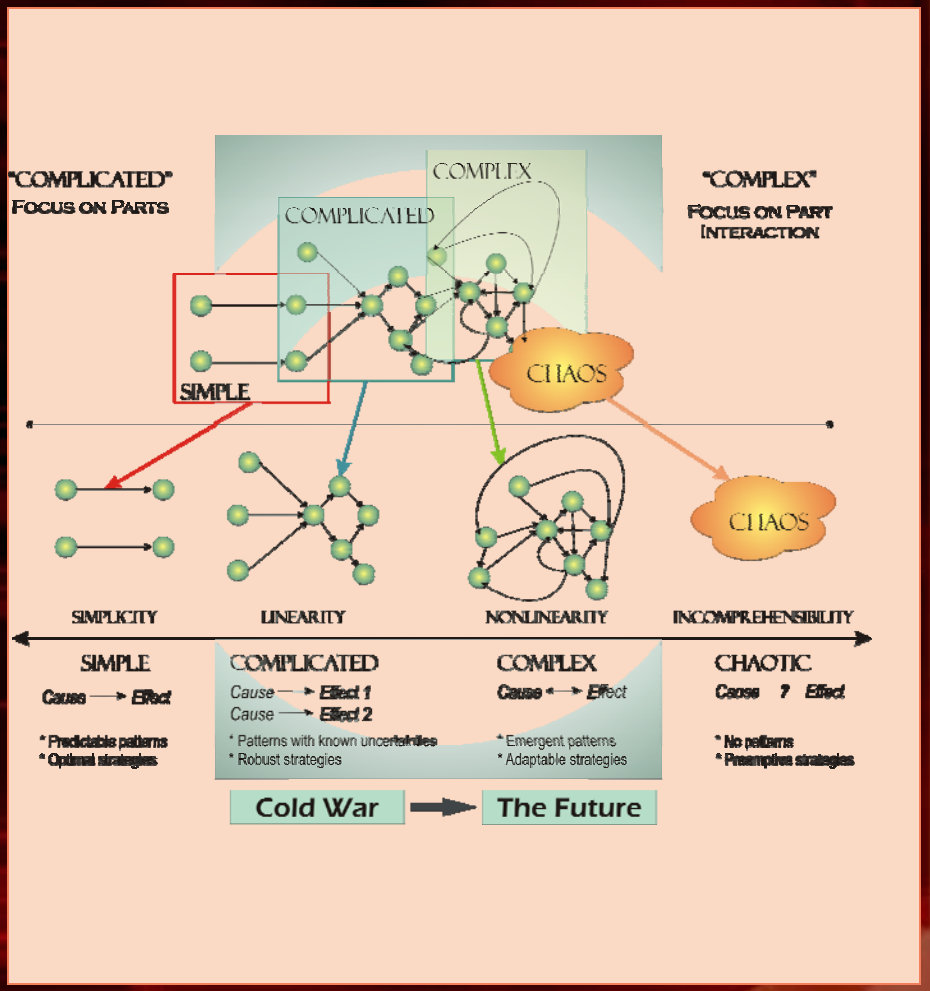
Disruptive Innovation

Disruptive Innovation … intentional or strategic employment of radical, novel or emerging approaches in a fashion that results in fundamental changes in capabilities, processes or outcomes.

- **General Posit** … analysis, and it's ability to support decision-making, constitutes an means to innovation
- **Specific Assertion** … inquiry approaches supported by advances in technology, primarily in informatics and "modeling, simulation & gaming," provides a means of achieving disruptive innovation
  - Beyond traditional notions of efficiency and effectiveness
  - Necessary approaches for dealing with longnow or "wicked hard" problems

Historical Precedents

- Decisions supported by an ability to ask questions about the world (analysis, synthesis, inquiry, etc.)
- Desire is to influence the world in a fashion to achieve goals of interest
  - Or, to at least avoid the “bad things” that could happen
- Policy analytic community provides an interesting example
  - Early 1900s, field was populated by individuals with training in law, divinity, etc.; or folks of social standing
  - 1920s, emergence of a “profession” largely populated by accountants
  - Emergence of policy analysis from ORSA community roots, occurred in the late 1960s
  - Late 1900s illustrated how practice has reached limitations
    - Inability to easily cleave “fact from value (context)”
    - *Complex* problems gained preeminence over *complicated* problems
  - What tools do we use now?

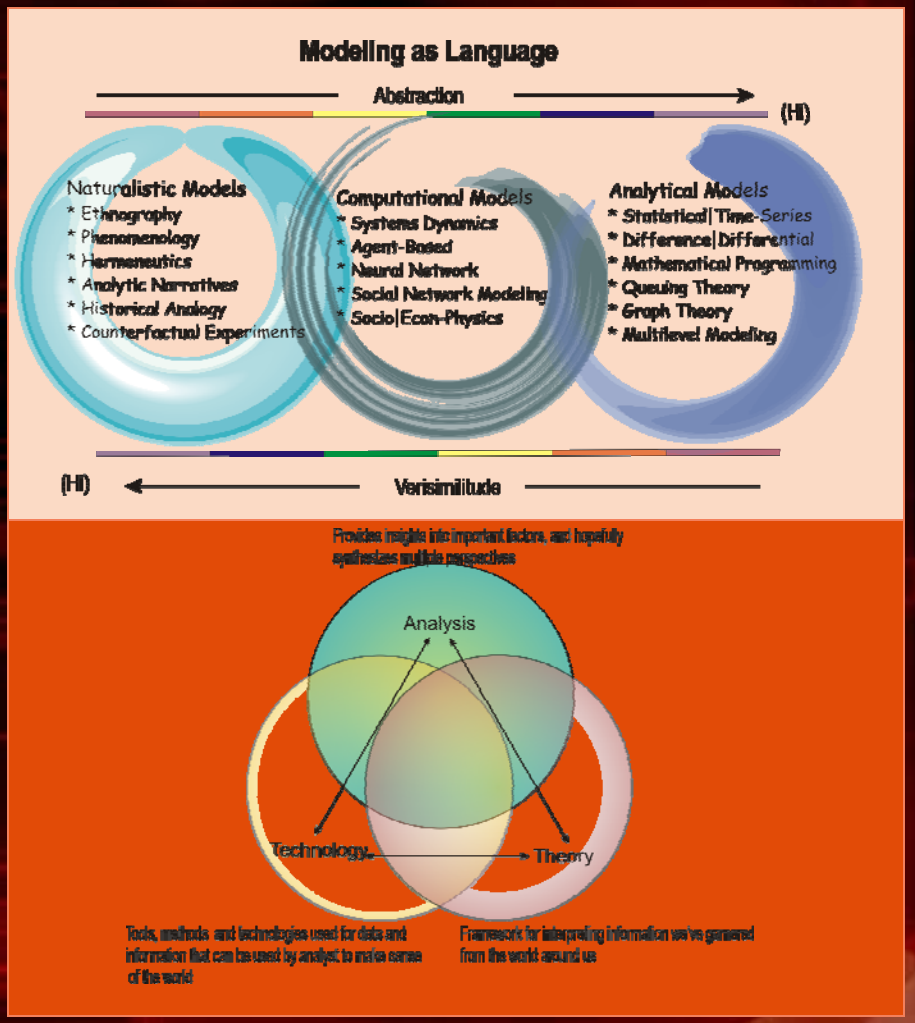


Disruption in the Realm of "Analysis & Decision"

- Analytic production
  - What is of importance to a decision-maker?
    - The ability to confirm "his or her" intuitions
    - Preponderance of evidence to support a "wow, who would have thought moment"
- Disruptive analytic capabilities would assure the above, but would also …
  - Support the consideration of highly "complex," or inter-coupled, problems
  - Give rise to ability to explore longer timelines
- "Shaping" capacity
  - **Shaping** … the ability to formulate and implement strategies or policies that give rise to a desired societal trajectory
  - Requires an ability to explore efficacious strategies, anticipated discontinuities, and co-evolutionary pressures
- Advanced analytics in support choice-making accounts for the capacity of a situation to change, or an adversary to learn
  - Advanced OODA-training

Commercial Possibilities

- Commercial possibilities arise from the Academy and the private sector
  - Revisiting the "body of human knowledge"
    - "Stuff" beyond the physical sciences
    - Interesting possibilities in the social and behavioral sciences
  - Consumers include the intelligence communities and C^2 staffs (strategic intelligence, consequence assessment, "strategy-task" v2.0)
- A focus area of note … advanced analytic (inquiry) technologies
  - Interesting business models emerge; analytic product is more important than technology artifact
  - Intuition augmented by formal notions of behavior



Actions by DOD

- Investments in the exploitation of the “social & behavioral” sciences
  - Note … fields are nascent compared to physical sciences, as well as different
    - Rate of return on investment is substantially greater than marginal improvements
    - Capacity is necessary, regardless of “youth”
    - Cool means of exploitation
      - “Six or so things to do with a bad model”
- Initial focus should be on insight-generation (enhancing the capacity of the analytic corps), and the ability to communicate complex ideas to decision-makers
  - Context (modeling)
  - Option Visualization
  - Collaboration

Real-Time Spectrum Management for Wireless Networks

Dan Stevenson, Arnold Bragg

RTI International, Inc.

Research Triangle Park, NC

Outline

- Problem statement
- Disruptive idea
- Details: approach, issues, architecture
- Summary and conclusions

Problem Statement

- Increasing spectrum pressure on DoD
  - Commercial demand for wireless services
  - Network Centric Warfare needs more bandwidth
- Manual decision and approval process
  - Spectrum XXI (SXXI) support tools
  - Reassignments are infrequent – days, weeks
- Private property model
  - Exclusive use
  - Leads to inefficient frequency utilization
  - 2-15% depending on band

Disruptive Idea

- Dynamic (real time) spectrum allocation
- FCC vision for commercial systems
  - Abandon the private property model
  - Decision driven by economics, policy, technology
  - 10 year process
- What does this mean for DoD?
  - DoD needs more spectrum for network centric warfare
  - Could wait for FCC process
  - More freedom of action possible within DoD spectrum

Approach and Payoff

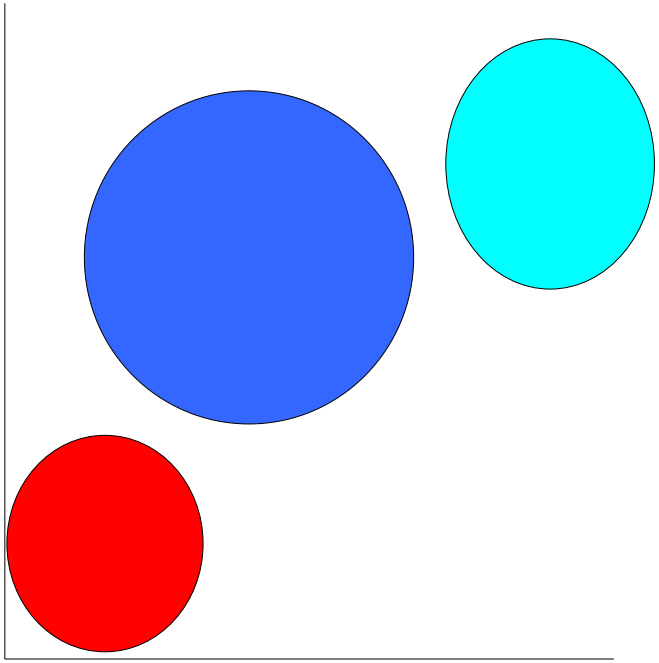
- Adapt FCC dynamic spectrum vision to DoD needs
  - Dynamic reassignment of frequencies within DoD bands
  - Use a private commons model
- Manual policy for bands of frequencies
  - Based on current practice, SXXI assignments, etc.
- Dynamic spectrum allocation potential
  - Assuming 50% spectrum utilization
  - 4 to 25 x more data passed in existing spectrum

DSA Requirements

- 1. Need to know what spectrum is available
  - Solved problem – DARPA xG: 10 μ sec
- 2. Need an infrastructure
  - Software defined radio is a mature technology
  - Reuse existing systems to extent possible
- 3. Need real time spectrum management
  - Existing adaptable solutions
  - Wired network algorithms for resource sharing

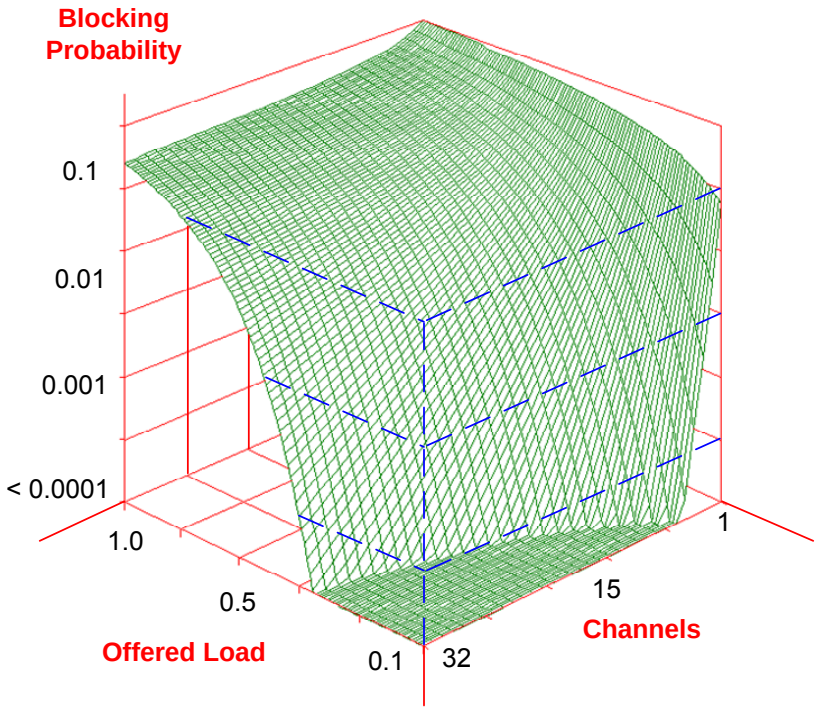
DSA Issues

- Wireless DSA requires sub-second provisioning
- DSA must also support longer term assignments
  - Tactical missions ~ hours
  - SXXI ~ days to weeks
- Priority & preemption support
- Fairness
- Application flexibility
  - Variable channel size & spacing



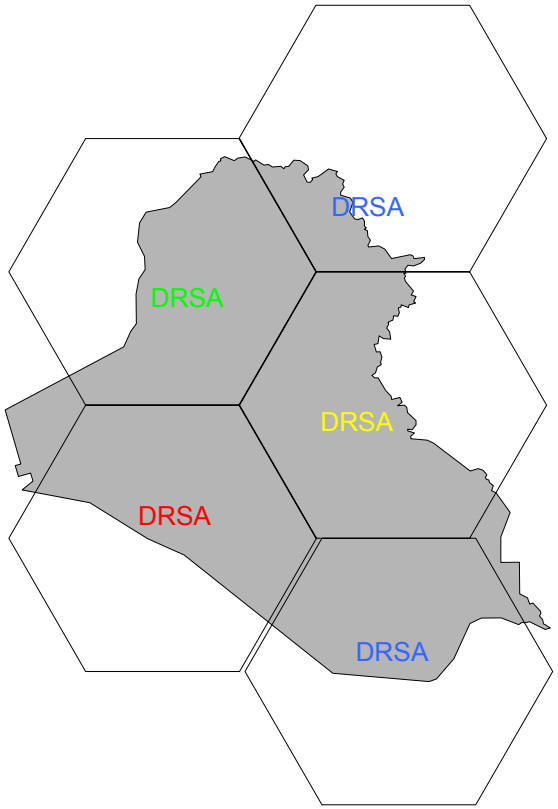
DSA Issues cont.

- Performance
  - Sub-second provisioning provides 2 – 10 x gain in efficiency
  - Negligible blocking
- Transparency
  - Real-time infrastructure sharing
  - Without manual intervention
- Must be difficult to misuse
  - Avoiding everyone is trusted pitfall



Possible DSA Architecture

- Structure bands as a private commons
  - Use SXXI for de-confliction planning
  - Spectrum divided into channels
  - Geography divided into cells
- Dynamic Real Time Spectrum Arbiter per cell
  - Multiple shared signaling channels
  - Arbitrate channels for end nodes
  - Keep local state – e.g., idle channels, usage
- Cell size varies, based on:
  - Frequency band, power level
  - Interference tolerance, policy
- Structure
  - Overlays
  - Sub-division



Signaling Channel Issues

- Multiple shared signaling channels
- Used for RF channel assignment & arbitration
- Existing solutions
  - SS7, GMPLS, SIP
    - Too slow, too complex
    - Missing key features: security, signal quality, variable allocation
- New methods proposed for commercial DSA are:
  - Complex
  - Based on research projects, most un-proven

Way Forward

- DoD “private commons” model
  - Potential to streamline process for military bands
  - All the technology pieces are here
    - 1. What spectrum is available – DARPA xG
    - 2. Infrastructure – frequency-agile SDR
    - 3. Real time spectrum management – existing adaptable solutions
    - 4. Complements SXXI
- Operational Implications
  - More bandwidth moved through available spectrum
  - Notch agile jamming

Conclusions

- Bad news: we aren't making any more spectrum
- Good news: we are wasting what we have
  - Today's DoD private property model → 2 – 15% average utilization
  - Commons model → potential for 4 – 25 times more traffic with same spectrum
  - We can recover much of what we're wasting
- FCC initiatives in commercial sector
  - Replace private property model with dynamic spectrum allocation
  - Increase utilization
  - Regulatory, economic, technical dimensions to solution
  - 10 – 15 year timeline – DoD can't wait

Backup

Just In Time

- Spectrum management control plane protocol
  - Physical layer agnostic
  - Pre-emption and priority support
- Existing implementation (TRL 7)
  - Field trialed (optical networks), documented
  - Open standard
- Signal quality monitoring
- Wicked fast (hardware implementation)
- Support for multiple administrative domains

IEEE Method

- Aloha like
  - Ok for commercial but
  - No planned notches for jammers for instance

http://www.orfm.noaa.gov/#Our%20Products1

- **The SXXI software was developed under the management and direction of the Department of Defense Joint Spectrum Center (JSC) and the National Telecommunications and Information Administration (NTIA). SXXI was developed to fulfill a need to automate many processes and to standardize the spectrum management processes throughout the Federal Government.**
- **The SXXI software enables users in any agency to:**
- **1. Maintain current frequency assignment records in a standardized database format with various selection and analysis capabilities.**
- **2. Maintain a database of communications-electronics equipment and associated technical characteristics in a standard format with various selection and analysis capabilities.**
- **3. Automatically select or nominate frequencies that are interference free.**
- **4. Automatically complete various frequency assignment and major system equipment certification application forms.**
- **5. Validate nominated frequencies via electromagnetic compatibility analyses with systems in the existing environment and perform hundreds of compliance checks on the accuracy of the nominated frequency assignments.**
- **6. Perform the NTIA-required five-year review of frequency assignments.**
- **7. Conduct engineering analyses and calculations to:**
- **a) convert coordinates from one form to another.**
  b) develop topographic charts of signal coverage.
  c) determine the necessary satellite look-angles of ground stations.
  d) perform HF skywave propagation analysis
  e) perform link analysis calculations.
  f) draw spectrum-occupancy graphs for frequency bands.
- **8. Perform interference analyses to:**
- **a) predict potential interference conflicts of new frequency assignment proposals.**
  b) identify potential sources to existing frequency assignments.
  c) nominate new frequencies.

Private Commons

- The FCC proposes that spectrum licensees be allowed to let others use their spectrum in a similar fashion to the unlicensed bands.
- The only types of devices allowed to operate in the “private commons” are peer-to-peer devices in a non-hierarchical network.
- Some current users of unlicensed spectrum would benefit by negotiating with spectrum owners to use their spectrum as a way to offer a service that is less crowded and thus potentially more valuable than services that operate in the unlicensed bands.
- Avoids the “tragedy of the commons,” where the shared item becomes so overused that it loses its value.

Joint Capabilities and Disruptive Technologies

MG MICHAEL A. VANE

Vice Director for Force Structure, Resources and Assessment, J-8

6 Sep 06

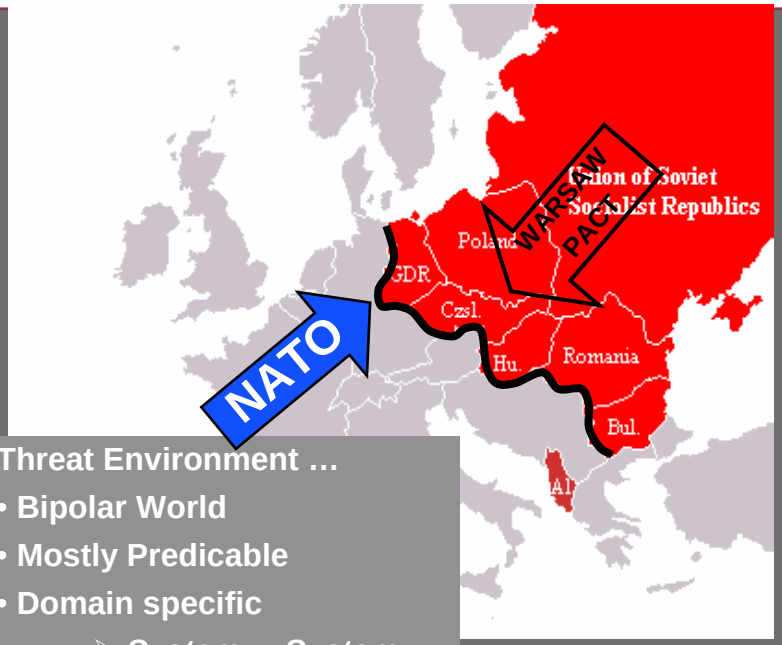
AGENDA

- **Strategic Environment**
- **Key Capabilities**
- **Acquisition Challenges**
- **JROC Initiatives**

Capabilities Based Planning
3 Years with JCIDS

Capabilities Based Planning (CBP)
Why Change?

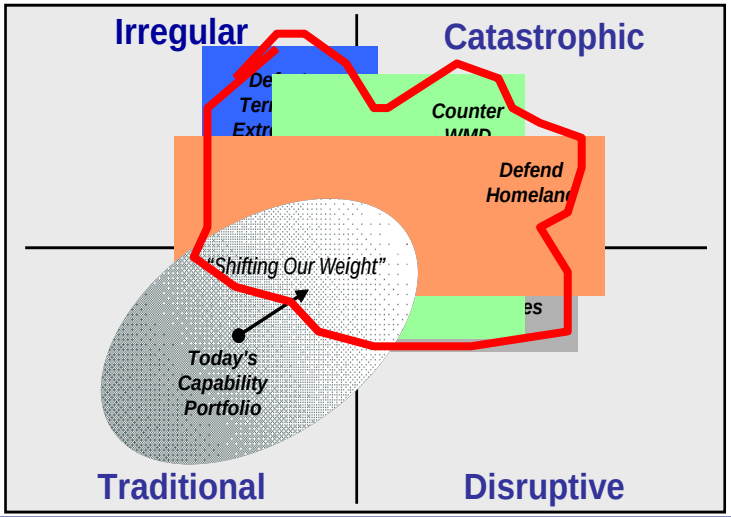
Requirements Generation System
~30 Years with RGS



Threat Environment …
- Bipolar World
- Mostly Predicable
- Domain specific
  - ➢ *System v. System*

Platform Centric Requirements Generation System

QDR Objective – Shift in Focus



Continuing the reorientation of military capabilities and implementing enterprise-wide reforms to ensure structures and process support the President and the warfighter

5

CCJO Characteristics of the Joint Force

Knowledge Empowered	Enduring/Persistent
Networked	Precise
Interoperable	Fast
Expeditionary	Agile
Adaptable/Tailorable	Lethal

JCIDS is a Deliberate Process to Deliver an Adaptable Force

DISRUPTIVE DEFINED

- **"***Disruptive* **challenges from state and non-state actors who employ technologies and capabilities (such as biotechnology, cyber and space operations, or directed energy weapons) in new ways to counter military advantages the United States currently enjoys."**
  - National Security Strategy, March 2006
- **"***Disruptive* **challenges may come from adversaries who develop and use break through technologies to negate current U.S. advantages in key operational domains"**
  - National Defense Strategy, March 2005
- **"Dual use civilian technologies, especially information technologies, high-resolution imagery and global positioning systems are widely available. These relatively low cost, commercially available technologies will improve the *disruptive* and destructive capabilities of a wide range of state and non-state actors."**
  - National Military Strategy, 2004

KEY CAPABILITIES - QDR

- **Disruptive Challenges**
  - **Electronic Warfare**
  - **Cyber Warfare**
  - **Counter Space**
  - **BM + CM**
  - **Next generation torpedoes**
  - **Adversary Submarines**
  - **Strategic nukes from land and sea based system**
  - **Theater UAVs**

- **Key Tools**
  - **Exercises**
  - **Experimentation**
  - **Training**
  - **Info Sharing**
  - **Intel Cooperation**
  - **Armaments Cooperation**
  - **Security Assistance**
  - **Humanitarian Assistance**
  - **Defense Support to Public Diplomacy**

KEY CAPABILITIES – QDR (Slide 2)

- **Shaping Choices of Countries at Crossroads**
  - **Improve the capacity of partner states**
  - **Reduce partner states vulnerabilities**
    - **Integration of defensive systems**
      - **Intel Sensors**
      - **Communication Networks**
      - **Information Systems**
      - **Missile Defense**
      - **Undersea Warfare**
      - **Counter Mine**
- **US diversify basing posture to promote constructive bilateral relations, mitigate anti-access, and offset potential political coercion**
  - **Mobility/Logistic Support**
  - **Operational Enablers – ISR, C2, Communications**
  - **New TRIAD**

SHARED ACQUISITION CHALLENGES

- **Realistic performance requirements**
- **Ensure COCOM needs are met**
- **Focus on most important issues**
- **Gain senior leader input earlier in development cycle**

JROC INITIATIVES

- **Senior leaders involved earlier in the process**
  - **Technical, Requirements, Funding Insights**
- **Concept Decision**
  - **Improve integration of key decision processes—Requirements, Acquisition, PPBE**
  - **Determine optimum investment strategy**
  - **Balance capability needs with technical feasibility and affordability**
- **Improved, more consistent KPP selection process**
  - **Mandated Materiel Readiness KPP with supporting Reliability and Ownership Cost KSAs**
  - **Increased focus on Systems Training and Energy Efficiency as potential selectively applied KPPs**

RAPID ACQUISITION

- **Joint Urgent Operational Need (JUON)**
  - **COCOM identified urgent need involved in an ongoing named operation**
  - **Inherently Joint**
  - **Outside of established Service rapid fielding processes**
  - **DOTMLPF solution if left unfilled:**
    - **Could result in loss of life**
    - **Near term mission failure**
  - **<ACAT 1**
- **Immediate Warfighter Need (IWN)**
  - **A JUON requiring 120 days or less material or logistics solution**

- **JUON Requests (FY05-06)**
- **C2 Net Centric**
  - **Blue Force Trackers** 491
  - **Radios** 167
  - **SATCOM Equipment** 38
  - **Spectrum Analyzers** 85
- **Battlespace Awareness**
  - **Unmanned Aerial Systems** 204
  - **Aerostat** 9
  - **Sensors** 36
  - **Full Motion Video** 535
- **Force Protection**
  - **Robots** 664
  - **Sensors** 335
  - **CREW** 26,930
  - **IR Defeat Systems** 3,498
  - **Robot Repeaters** 435
- **Focused Logistics**
  - **JPDADS** 38
  - **Generators** 18,889
  - **Vehicles** 618
  - **Float Bridge** 1

Capability Gap Assessment

Gap Synthesis & Assessment

FCB Assessment & Prioritization

JCB

JROC

Approved Gaps Priorities Guidance

Most Pressing Military Issues

Capability Issue Inputs

OSD
- QDR; SPG; TPG; Roadmaps; S&T; Analytic Agenda; SCG; CPG, Defense Agencies

COCOM
- IPL; LL; WOT; DCR; JUON; 7500

SERVICEs
- JCDs
- Vision/Concepts
- Service challenges

Joint Staff
- OA Studies
- Concepts
- CRA
- JQRR

JFCOM
- Transformational Issues
- Joint Experimentation

Decisions/Guidance

Accept Risk

Support POR/On Going Efforts

Identify Material/ Non-Material Solutions
- Reprogram or provide additional funding for ongoing programs
- OSD
  - ACTD-JCTD; S&T Investment
  - Roadmaps
  - Acquisition
- FCB / Services
  - CBA

Develop concepts and experiments that determine how to solve a specific military problem
- JFCOM
  - Joint Experimentation
- Joint Staff
  - Concepts
- OSD
  - S&T Investment; Industry; Conduct CBA
- Service
  - CBA; DCR; Concepts / Experimentation

Study Specific Military Issues
- OSD/Services/Joint Staff
  - Operational Availability Studies and Sub-studies

Semi-annual Repeatable Process

SUMMARY

- **The strategic environment has changed**
  - ***Deliberate process to deliver an adaptable force***
- **Process evolved from requirements driven to capabilities based**
  - ***Translate guidance/policy into Joint Force capability***
- **Early insights by senior leaders enhance acquisition stability**
  - ***Realistic requirements to meet warfighter needs***
- **MPMI provides the focusing construct**
  - ***Top-down guidance to solve pressing military issues***